MACHINERY.

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MECHANICAL DRAFT.—5.

A DESCRIPTION OF DIFFERENT METHODS OF APPLICATION, WITH RESULTS.

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THE methods of application of mechanical draft may be broadly classified under two heads—the plenum and the vacuum methods. Although both were experimented upon by Stevens in 1827 and in the succeeding years, yet the former remained for a long period practically the only form in which mechanical draft was applied. As the term implies, the air under the plenum method is forced through the fire; that is, the pressure maintained below the fire is greater than that of the atmosphere; hence the general term "forced draft."

Under the plenum method the air may be supplied in either of two ways. First by making the ash-pit practically air-tight and then forcing into it the air in sufficient quantity and under the requisite pressure. Evidently the only escape for the air being through the fuel, it must all be utilized for the purpose of combustion. Second, by making the fire-room itself air-tight and maintaining therein the required air pressure by means of a fan of sufficient capacity to constantly make good the amount of air which under pressure passes to the ash-pits and thence through the fuel.

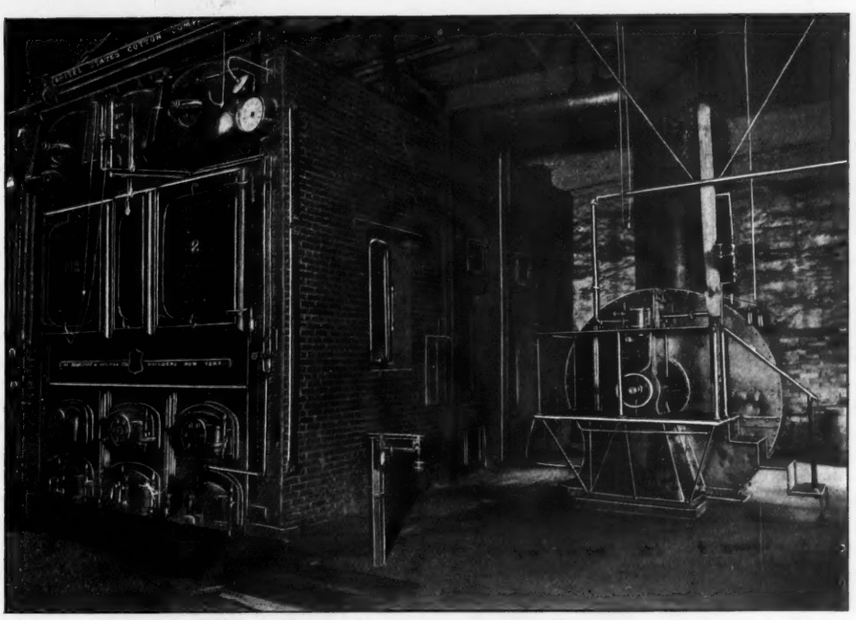


FIG. 3. ARRANGEMENT OF A PLANT AT CENTRAL FALLS, R. I.

Under the vacuum method there is practically only one means of application—that by the introduction of an exhausting fan in the place of a chimney. This is commonly known as the "induced" or "suction" method. The fan thus serves to maintain the vacuum which would exist if a chimney were employed, and its capacity can be made such as to handle the gases which result from the processes of combustion. A short and comparatively light stack usually serves to carry these gases sufficiently high to permit of their harmless escape to the atmosphere.

Evidently the method of application to be adopted must depend upon the circumstances. It cannot be unqualifiedly asserted that under all conditions any one of these principal methods, or their numerous modifications, is superior to the others.

The closed ash-pit system was naturally first applied because of its ready adaptability to existing conditions, and for the same reason it has, to a great extent, been the system introduced wherever, in an existing plant, it has been desired to burn a cheaper grade of fuel or to add to the steaming capacity. When properly applied, the air admitted to the ash-pit under pressure should be compelled to pass through the fire in an even volume. Local impingement of the air upon any particular portion of the grate must be most carefully avoided in order that there may be no danger of burning out the grate. Intelligently distributed this danger should be entirely avoided. Two excellent arrangements, known as ash-pit dampers, designed for this particular purpose, are presented in Figs. 1 and 2. The former is designed for use when the air duct is under ground either in front of, or immediately beneath the ash-pits. It consists of a frame thoroughly imbedded in the brickwork, a door hinged thereto and a handle bar for operating it. The door is countersunk in the frame so that when closed the top is perfectly flush and ashes may be readily raked over it. The handle bar is notched so as to permit of adjustment to suit the conditions. The door when open serves to deflect the air and thoroughly distribute it in the ash-pit. The latter type of damper is particularly useful when it can be applied in the original construction of the boiler setting. The air duct is in this case constructed within the bridge wall. Each damper is provided with an extended shaft and lever, so that it may be operated from the boiler front by means of the long handle bar. As the air leaves the duct and passes through the damper, it is deflected downward, spreads over the entire bottom of the ash-pit and thence rises in an even volume at low velocity to the grate above. Either of these arrangements obviously necessitates keeping the ash-pit doors closed.

In marine boilers with internal fire-boxes such arrangements are usually inadmissible. Ordinarily the air is admitted through the ash-pit doors, or the openings provided for them. This necessitates a removable arrangement so that the ash-pits may be cleaned. Numerous devices have been applied for this purpose, varying greatly in success and convenience. An excellent device, the invention of Mr. John C. Kafer, has been applied on some of the vessels of the United States Navy as well as in the merchant marine. The air is admitted through a duct beneath the deck and passes to the ash-pit and also to the space between the inner and outer plates of the fire doors, through a connection at the front of the boiler. The air pressure therein being greater than the air of the fire-room or the gases of the furnace, all leakage is from this space into the fire-room and the furnace. A hinged valve in the air duct, as closed, shuts off or regulates the supply of air to each furnace and is operated by a lever from the fire-room. When the valve is open the lever is fitted to lock the closed furnace door, thereby preventing the door and valve from being open at the same time.

The practical results of the introduction of the closed ash-pit system in place of natural draft may be shown by reference to several plants thus equipped. Thus, for instance, the Crystal Water Co., of Buffalo, N. Y., is employing an arrangement of dampers similar to that shown in Fig. 2, the fan outlet being fitted to the end of the duct in the bridge wall and discharging directly into it. The draft pressure varies from ½ to 1½ inches of water according to requirements, 20 to 30 pounds of coal are burned per square foot of grate per hour and the formation of smoke is entirely avoided. Although they have a large stack with good natural draft, they cannot burn the same fuel as fast or as efficiently therewith, nor can they avoid the production of smoke when the chimney is in use. The fuel is a four-to-one mixture of hard coal screenings and soft run of mine.

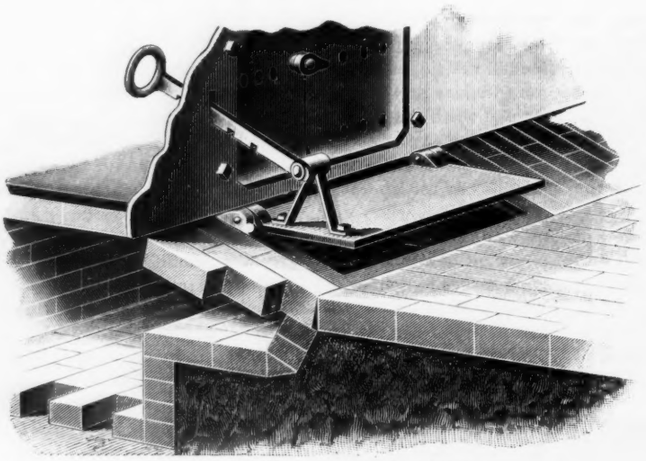


FIG. 1. ASH-PIT DAMPER AT FRONT OF BOILER.

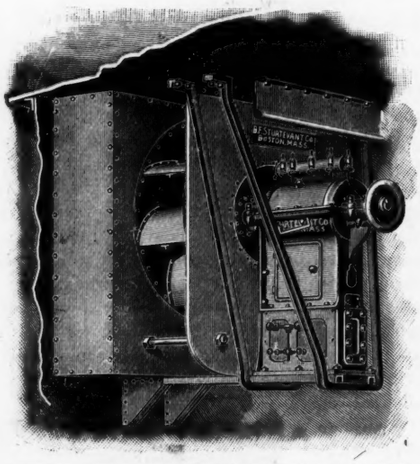


FIG. 4. FAN AND ENGINE FOR MARINE WORK.

Another instance is the case of the United States Cotton Co., at Central Falls, R. I. Here the boiler plant consists of three Babcock & Wilcox boilers of 335 horse power each. The draft is furnished under the closed ash-pit system, the speed of the fan being automatically regulated by a special device, so that the volume of air and intensity of draft are continually changing to suit the varied conditions and requirements of the fire. Before this mechanical draft plant was put in operation the fuel employed was George's Creek Cumberland, costing $4.00 per ton of 2 200 pounds, delivered at the boiler-room. Since the fan has been in use the quality and price of the fuel has been reduced to a mixture of about 70 to 75 per cent. of No. 2 buckwheat, 20 to 25 per cent. of yard screenings and 5 to 10 per cent. of Cumberland, costing $2.62 per ton. This change has reduced the fuel cost per indicated horse power on the engine by $0.001235 per horse power per hour. On the horse power developed by the engines, the resultant saving is over $126 per week, when all fuel, including that used for banking fires is taken into account.

The general arrangement of this plant is very clearly shown in Fig. 4, reproduced from a photograph. The fan discharges through its open bottom into a duct beneath, which conducts the air to the ash-pits of the various boilers, the front of one of which appears. A compact enclosed upright compound engine serves to drive the fan to which it is direct connected.

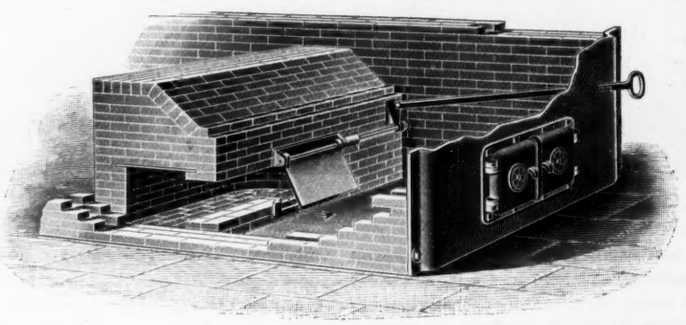


FIG. 2. ASH-PIT DAMPER IN BRIDGE WALL.

TABLE NO. 20.—SAVING BY FORCED DRAFT ON S. S. DANIA.

Conditions.	Day's Steaming.	Knots per Hour.	Consumption of Coal per Day.	Consumption for all Purposes per Day's Steaming.
Natural draft....	17.00	7.50	9.73	10.70
Forced draft.....	16.21	7.68	7.76	9.31

As shown by the accompanying Table No. 20, the results of the introduction of closed ash-pit forced draft on shipboard are evidence of increased economy. This record, which covers four voyages, shows that the total consumption of coal was reduced 13 per cent., while the time occupied in making the voyage was decreased nearly 5 per cent.

Although the closed fire-room system has been far more extensively applied in the naval marine that has the closed ash-pit system, it has been largely due to the existing conditions, for there can be no doubt but that, of the two, the latter is more satisfactory when the conditions permit of its introduction. But this unfortunately is too seldom the case, particularly on naval vessels. The closed fire-room system, in which a plenum condition is maintained in a practically air-tight fire-room, is evidently impracticable for general boiler practice on land. Its existence is in fact largely due to the exigencies of modern naval warfare, for it is necessary that during an engagement the openings down to the engine and boiler rooms should be kept as small as possible, and in all cases the machinery department would be closed down and air supplied by artificial means during an engagement. Fans installed upon the closed fire-room principle can be easily arranged to ventilate the engine and fire rooms as well as to increase the combustion rate. To a great extent, if not almost universally, fans are introduced in naval equipment for the purpose of increasing the steaming capacity only when the maximum speed is required, and are not intended to be used under ordinary cruising conditions.

TABLE NO. 21.—RESULTS OF TRIAL PERFORMANCES OF SIMILAR SHIPS OF BRITISH NAVY.

Draft.	Ship.	Date.	Steam pressure, pounds per sq. in.	I. H. P.	Weight of Boilers, tons.	Area of Fire Grate, sq. ft.	I. H. P. per Sq. feet of grate.	I. H. P. per Ton of Boiler.
Natural Draft, open Fire-rooms.	Inflexible	1878	60	8483	756	829	10.21	11.22
	Colossus	1883	64	7492	594	645	11.62	12.61
	Phæton	1884	90	5588	462	546	10.23	12.1
Forced Draft, closed Fire-rooms.	Howe	1885	90	11725	632	756	15.54	18.5
	Rodney	1885	90	9544	474	567	16.83	20.1
	Mersey	1885	110	6628	306	399	16.61	21.7
	Scout	1885	120	3370	174	207	16.28	19.3

The increased steaming capacity per square foot of grate and per ton of boiler, which result from the introduction of mechanical draft, is shown in the case of the closed fire-room system by the results of trial performances of vessels of the British navy, as presented in Table No. 21.

The weight of boiler includes water, funnel, uptakes, fittings, spare gear, etc. Steam blast was used in the case of the Colossus.

In the later vessels there were improvements in the way of

more economical engines, yet the greatest saving in weight per indicated horse power was brought about by the introduction of mechanical draft. These tests, which were in the early days of its introduction in the naval service, exerted a strong influence on subsequent construction.

Although almost any type of fan is serviceable for use under this system, yet the simplest is one like that shown in Fig. 4. Here the fan case is open around the entire periphery, allowing the air free escape. The double cylindered upright engine being rigidly suspended from the deck above, makes high rotative speed possible and avoids the use of space otherwise valuable.

FROM AMONG THE SHOPS.

SOME SPECIMENS OF VERTICAL AND HORIZONTAL MILLING—AN IMPROVED SURFACE PLATE—NOTES FROM DIFFERENT SHOPS.

The engine lathe has been with us a long time, and when it came it came to stay. Once in a while, however, some of its brother machines tread on its toes in the matter of getting out lathe work, and Fig. 1 shows three such pieces that were not done in an engine lathe. The are products of the Becker vertical milling machine, and are parts of this machine as made in the Becker shops at Fitchburg, Mass.

Certain sizes of the machine are fitted with a circular milling attachment, consisting of a circular table gibbed and clamped to a saddle that can be bolted to the milling machine table. The circular table has power feed and the clamping arrangement is such that it can be made to operate rather stiffly, if desired, without danger of cutting the bearing surface, thus taking up any lost motion; and as the table sets low and has a generous bearing, any possibility of chattering is avoided.

Circular milling has decided advantages over turning in the lathe for certain classes of work, just as plain milling in many cases takes precedence over planing, and for the same reasons. Where work is of irregular shape it is a case of formed cutter *vs.* single pointed tool, and if the work will stand the cut and is stiffly supported, there is not much to be said for the single pointed tool.

Such a piece, set on the circular milling table, can be allowed to run until the cut runs out and does not require an experienced man to attend it.

In Fig. 1, the worm gear shown is 13 inches outside diameter, 7⅜ inches inside and two inches thick. It is first squared up on one side in the lathe and finished all over on the milling machine; the time for milling, as stated by Mr. N. E. Johnson, the general foreman, being 1¼ hours. The two other circular pieces shown in the cut were done in a proportionately short time. The milling machine saddle appearing at the right is a piece of straight milling work that is a good subject for the vertical milling machine and on which a large saving is made over the time that it used to take to finish the piece on the planer. The piece measures 8 x 10 inches and is finished easily in 2½ hours. In milling, one cut is taken over the top with a large inserted tooth cutter; 2d, it is turned over and two edges milled; 3d, put in vise and both ends milled; 4th, turned around in vise and beveled edges and bottom finished.

FIG. 1. EXAMPLES OF VERTICAL MILLING.

BORING MILLING MACHINE SPINDLES.

In the way of time saving, a creditable piece of work has been done in the reduction made in manufacturing the Becker milling machine spindles. These spindles are hollow to allow the use of a draw bar for holding cutter arbors, or the shanks of mills, in place and were formerly bored in an ordinary lathe, with a flat drill.

In Fig. 2, is a view of a lathe that was afterwards fitted specially for the work at a small expense and which reduced the time in boring one size of spindle from 4½ hours to 45 minutes—a very respectable saving.

In boring, the spindle is back-rested and is supported at the face-plate end by a special holder and driven by a dog. The long drill used is held by a fixture, taking the place of the tool block on the carriage, and is fed by means of the carriage feed, the usual rate in tool steel being .06 inches per minute. The drill is of the usual D type, commonly employed for drilling long holes; that is, it consists of a bar of Stubb's steel, with one half milled off, leaving an end view of the cutting end in the shape of a letter D, or of a semi-circle. There is but one cutting edge and the "philosophy" of the drill is that as it advances the round part bears in the hole already drilled, and forms a support for the cutting edge and guides it in a straight path. The part cut away allows the chips to escape.

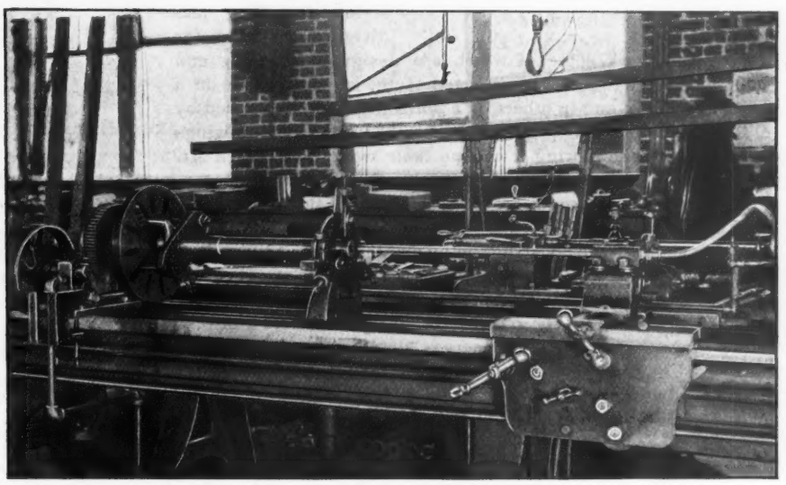


FIG. 2. BORING SPINDLES.

A forced oil supply is necessary to wash out the chips and thoroughly lubricate the drill. The oil pump is shown at the left of Fig. 2. The flexible connections are made by means of Almond flexible tubing. In lieu of a better means of getting oil through the drill, a small hole was drilled in each end of the rod and a groove milled the whole length from hole to hole. The groove was then closed by staking in a long strip of metal, leaving a channel underneath for the oil to flow through.

A JOB DONE ON A HORIZONTAL MACHINE.

While the vertical milling machine is of great value as a tool of general utility and for doing rapid work, occasionally a job is found that would be classed as "vertical milling," but that can be done to better advantage on a horizontal machine, if fitted for it.

Such a one was seen a short time ago at the D. E. Whiton Machine Co.'s, New London, Conn. In the manufacture of reversible jaw scroll chucks the jaws are dove-tailed to the piece having the teeth which gear in the scroll. Fig. 3 represents the blank pieces as they are fitted together and before either is finished ready for the chuck.

In milling the dove-tailed grooves several pieces are clamped together in fixtures, giving them the right inclination. Two cutters are used at once, one for each groove, with a collar between. The general arrangement of cutters and work is as

indicated in Fig. 4. At the left is shown the piece which is marked (A) in Fig. 3, and at the right, piece (B).

In doing the work a cut is first taken through the solid blank, leaving a groove the exact shape of the cutter; the pieces are then reversed and the second time through the grooves are completed. In each case in Fig. 4 the cutters are shown taking the second cut. This method is not only rapid, but pieces done in this way duplicate very well and the cutters wear much longer without regrinding than would small end mills.

INSERTED TOOTH FACE MILLS.

The firm of Beaman & Smith, of Providence, R. I., while manufacturing a line of regular machine tools, are largely engaged in building special tools. This has given them an opportunity for the development of ideas, which has resulted in the building of several styles of milling machines intended for very heavy work, some of which are designed for using end mills and large mills with inserted teeth, in some cases on a vertical spindle, and in others on a horizontal spindle carried by a side-head. The accompanying sketches are from drawings which were seen during a call at their works and which Mr. Smith kindly consented to have reproduced for publication.

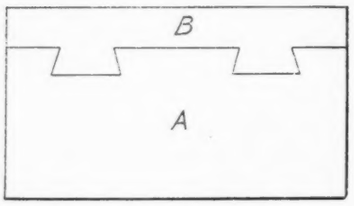


FIG. 3.

The bodies of the mills are of cast iron and the types shown in Figs. 5 to 8 have steel rims on their periphery. These rims not only simplify the construction by making it easier to mill or plane the grooves for the cutters, but add to its strength and afford a good material to resist the wear of the set screws, which are of tool steel. In Fig. 6 there are so many cutters that they touch each other and the rim serves simply as a clamping ring supported by the set screws.

In deciding upon the number of teeth for a mill, the character of the work to be done must be considered. When mills are to operate on heavy work where there is a large amount of stock to be removed, and the piece will stand all the pressure that can be put upon it, as many teeth should be used as possible. The pressure of the cut varies, but probably an average pressure of 400 pounds per tooth would be a safe allowance in roughing with a strong feed. The total pressure on many teeth, therefore, amounts to considerable when they are worked up to their capacity, and it is only on the heaviest class of work that the full benefit of a large number of teeth can be realized. Beaman & Smith have built machines which are running on ordinary cast iron with a feed of 13 inches per minute, which shows the capabilities of a stiff machine, the right kind of a milling cutter, and the right kind of work.

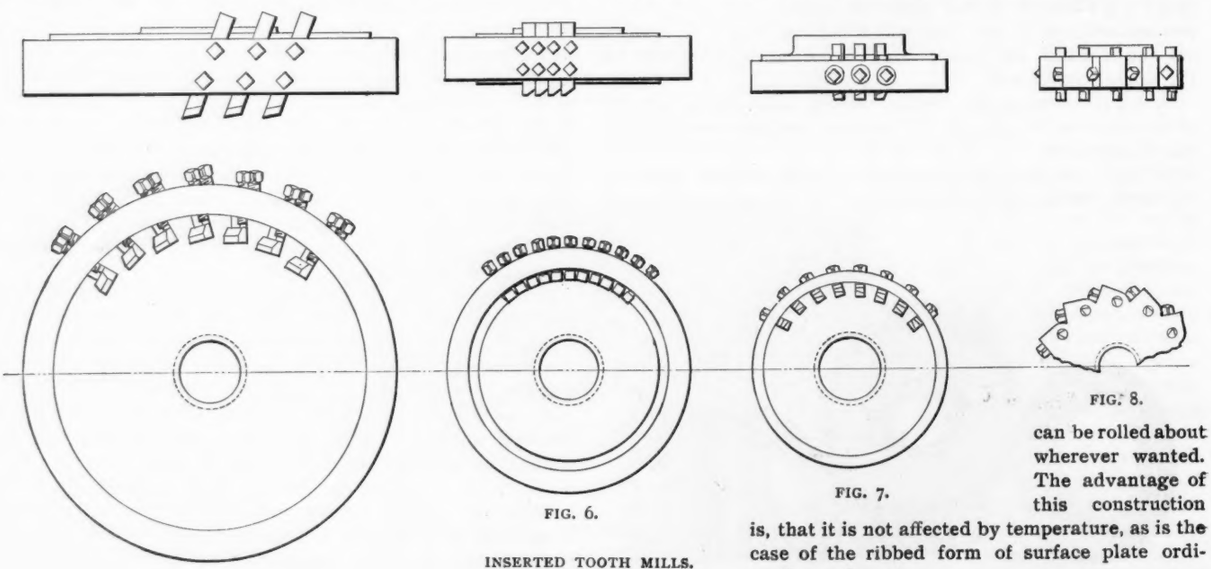


FIG. 5. FIG. 6. FIG. 7. FIG. 8.

INSERTED TOOTH MILLS.

A SURFACE PLATE ON CORRECT PRINCIPLES.

Through the courtesy of Bement, Miles & Co. we are able to present a drawing, Fig. 9, of a surface plate, which appears to us to be designed on common sense lines, and probably it will appear so to others. The ordinary form, consisting of a thin plate with ribbed back, must inevitably change somewhat with changes in temperature and from unequal internal strains in the iron, due to the unequal amount of metal on the face and at the back of the plate. In general machine construction the box section is considered the best, because of the uniformity of the metal all around, and the plate in question is made on this principle. The following explanation was sent us by Bement, Miles & Co.:

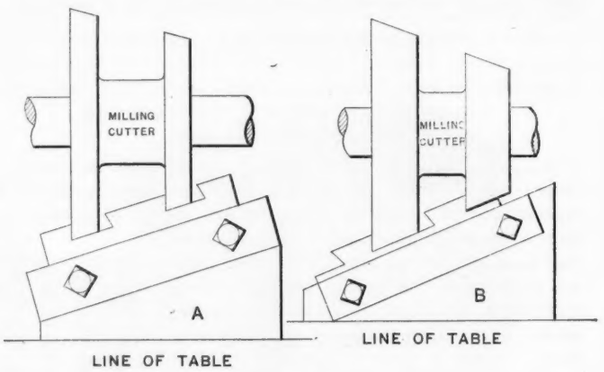


FIG. 4.

"In compliance with your request we herewith enclose you print, showing a top view and an end view with thickness of metal marked. The dotted ovals are apertures in the under side of the plate for removing the cores. The plates are finished all over on the outside, and very carefully trued up and finished by scraping. We have three of the plates in use in our establishment, of the dimensions given in blue print, which were made fifteen years ago. They have been taken good care of, and are as good as new. One is kept in the tool room, and only used for reference; the other two are in use in the works, when required. They are fitted with light special trucks, so that they can be rolled about wherever wanted. The advantage of this construction is, that it is not affected by temperature, as is the case of the ribbed form of surface plate ordinarily used.

"We had, of course, much experience with the ribbed form of plate made in the best manner, not only by ourselves, but by scientific makers of such instruments. We found in all cases that they would not stay true. These cored-out plates, on the contrary, maintain their perfection of truth from year to year. The two that are in use in the works are referred occasionally to the standard in the tool room, and if any slight variations are discovered, they are corrected. It takes the most careful observation and testing with the best instruments available, to detect that they are not perfect. We consider this the only way that we know of to make a good surface plate."

A CENTERING DEVICE.

The following description of a centering device has been sent us by Mr. "Hardcase." This device was found in the kit of Mr. Henry M. Loomer, of Mattapan, Mass., and some young mechanic may wish to make one like it.

It consists of a bar of ⅜-inch round steel about a foot long, with two forked pieces B guided by keys C sliding in a spline in the bar A. These forked pieces may be located under the head

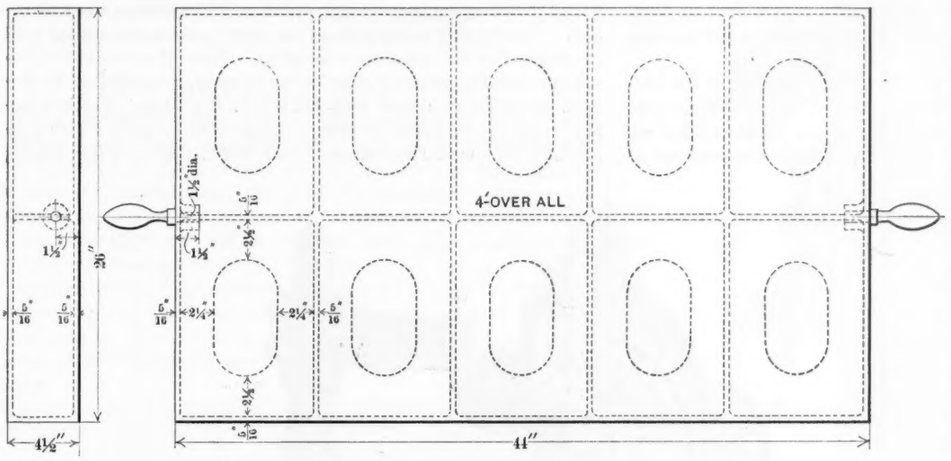


FIG. 9. A SURFACE PLATE.

of a bolt at such points as it is desired to center the work by, and clamped by the pointed thumb screws D, set into the keys.

Swinging on the end of the bar A, is a slotted arm E carrying an adjustable scribing point F. Placing the work C against the forked pieces, as shown, the scribing point is used to locate the center by scribing two or more lines H across the end of the work in different directions. Sufficient play is allowed in the joint between the slotted arm and the bar A, so that the scribing point may waver sufficiently to follow the unevenness in the surface of the work, while the slot permits the point to be set, and locked by the thumb nut, where it will swing by the center of any piece of work within the capacity of the tool.

The scriber may be made of a small piece of steel wire slightly larger than the width of the slot, threaded to fit the nut and flattened on two sides to prevent it turning with the thumb nut.

A centering device of this kind can be used on the end of a shaft almost anywhere, and the forked guides located at the points where it is desired that the piece should run truest, which will often save straightening, and makes it desirable in many places where an ordinary center square would be worthless. Take, for example, a crooked T-bolt with the head on one side like Fig. 11; by adjusting the forked guides B, as shown, and using ordinary care, it can be depended upon to run approximately true at a point near the small end and under the head regardless of the shape of the head.

I can see no reason why one of these devices could not be

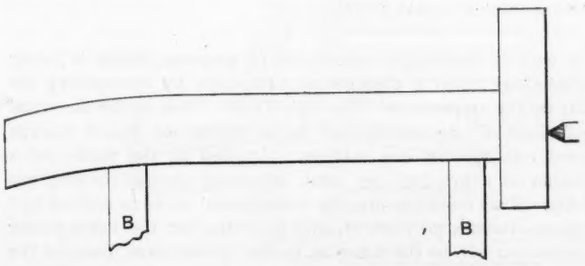


FIG. 11.

constructed on a larger scale with legs similar to B and find favor in many shops as a bench tool. It would facilitate the centering of some of the heavier work that is now centered by trial.

PRACTICAL ELECTRICAL DEFINITIONS.

LOUIS DENTON BLISS.

A general knowledge of electrical terms is almost essential to a person who is daily coming in contact with various classes of electrical machinery, or who reads electrical journals; and while a certain mystery surrounds electrical phenomena, when viewed from a practical standpoint, we find it possible to define clearly, as in light, not only quantity and intensity, but also pressure, rate of flow, resistance, and in many other ways deal with electricity, as though it were water, selling at so much per gallon.

Let us now consider the modern accepted theory of electricity, in order that we may intelligently name the various factors which go to make up this form of energy.

At the outset, there is no such *thing* as electricity, for it has no more individuality than light. It is simply a condition—a stress. Pervading all interstellar space, there is an imponderable fluid known as ether. This fluid passes with the utmost freedom through all substances, whether porous or solid, and passes through glass as easily as water through a sieve. An atom of ether is millions of times smaller than an atom of matter. This ether exists in vacuum, and in all substances whether there is atmosphere or not. We know of no place where it does not exist.

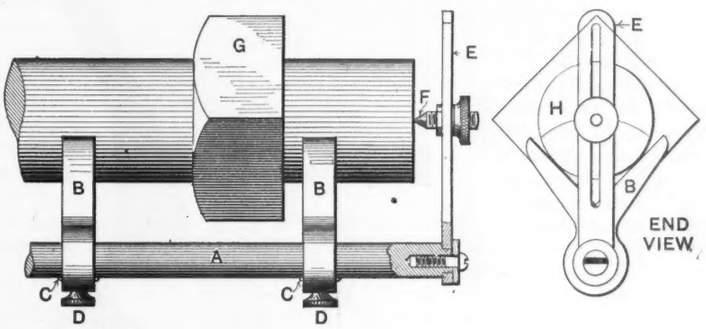


FIG. 10. A CENTERING DEVICE.

Setting fire to fuel, or rubbing two sticks together, will cause the ether atoms to be set in vibration, and this vibration will be communicated by means of waves to the adjacent ether at a considerable distance until we have a manifestation, or condition, known as heat.

If this vibration is caused by some other means, as when the filament of an electric lamp is raised to incandescence, the number is increased, and the length of the wave is shortened. This brings about a new condition which we term light.

Varying in some other way the source of vibration, we may bring about still a third state which we call electricity, so the most concise definition that can be given of electricity is to say that it is a condition of ether stress.

Electricity may be conveyed through a wire in the form of current, and it is in this condition that we most frequently find it.

Three important points must be considered in connection with any electrical work. First, before we can have any electrical current there must be a pressure to move that current; second, given the electrical pressure, and a path through which the pressure may exert its force, some volume of energy will be moved, and this we term the current; but we know that force cannot be expended, except against resistance, so the third consideration will be the resistance, or the electrical friction offered by the wire to the transmission of a given volume of electricity under a predetermined pressure.

Now, that which causes a current to flow in a wire is termed the electro-motive force, literally force moving electricity, and the units in which this force is measured is represented by *voltage*. That is, we say, the electro-motive force of a certain line is 150 volts. In a mechanical analogy, this would correspond to a pressure of 150 pounds on a water pipe with water in the pipe transmitting energy.

The volume or rate of flow in a wire, commonly called the current, is represented by the unit, *ampere*. No mechanical equivalent represents the ampere alone, because it is a rate of flow. That is, it corresponds in the water pipe to a gallon per second. It involves both quantity and time.

The resistance which the wire offers to the passage of the current, and every wire offers some, for there is no perfect conductor, is represented by the unit, *ohm*, so we would say that an electro-motive force of one volt would be a sufficient pressure to cause a current of one ampere to flow through a resistance of one ohm.

If it were possible to cause a current to flow from the end of a wire, and we were to hold a bucket there to catch the current flowing off the wire carrying one ampere, in one second of time, we would have caught a definite quantity of electricity. This is termed the coulomb (pronounced cool-ohm).

Let us compare the electric current in a conducting wire to a rifle ball in which the powder represents the voltage or pressure; the ball, the amperage or current; and the friction with which the ball meets in its passage through the gun, the resistance in ohms. If we place a ball weighing several ounces in the rifle, and place behind it only a few grains of powder, we may safely stand in front of the gun, as the resistance to its passage would be enormous. Thus, we may safely handle a wire carrying a thousand amperes of current, if we know the voltage is only one hundred; but if, on the other hand, we have placed in the gun an ounce or two of powder, and in front of it a ball weighing but a fraction of an ounce, no one would dare to stand in front of the gun when fired. So in electricity. It would be dangerous to receive a shock from a circuit carrying, say a few amperes, if that current is traveling under a pressure of several thousand volts. The slight resistance offered by the sides of the gun would not keep the ball from producing death because of the pressure behind it. Voluminous accounts are sometimes published in the daily papers of people being killed by three thousand volts of electricity. It is evident how erroneous this expression is, because the pressure will produce no effect unless there is some current upon which it can expend its energy in overcoming resistance. Thus if a person stand at a sufficient distance from a gun so as not to be burned, and the gun contained only powder, there would be no injurious effect produced because of the absence of any volume to force through the body, so that while it is evident that no pressure, however high, can injure us if there is no quantity in front of it, also no quantity of electricity can injure us if the pressure is too low to force it through the resistance of the body.

An electric plant may be compared to water flowing through an iron pipe connected to a reservoir above and passing to an outlet below. The reservoir corresponds to the dynamo. The height to which it is lifted will produce a certain pressure or voltage. The cross section of the volume of water or the rate at which it is flowing past a fixed point, will determine the amperage. The friction exhibited as the water passes downward will correspond to the resistance in ohms. Now, the product of the volume and the pressure, that is the amperage multiplied by the volt, will give us a new unit known as the *Watt*, which is the electrical unit of power or rate of doing work. In the water pipe analogy, this would correspond to the effect upon a water wheel.

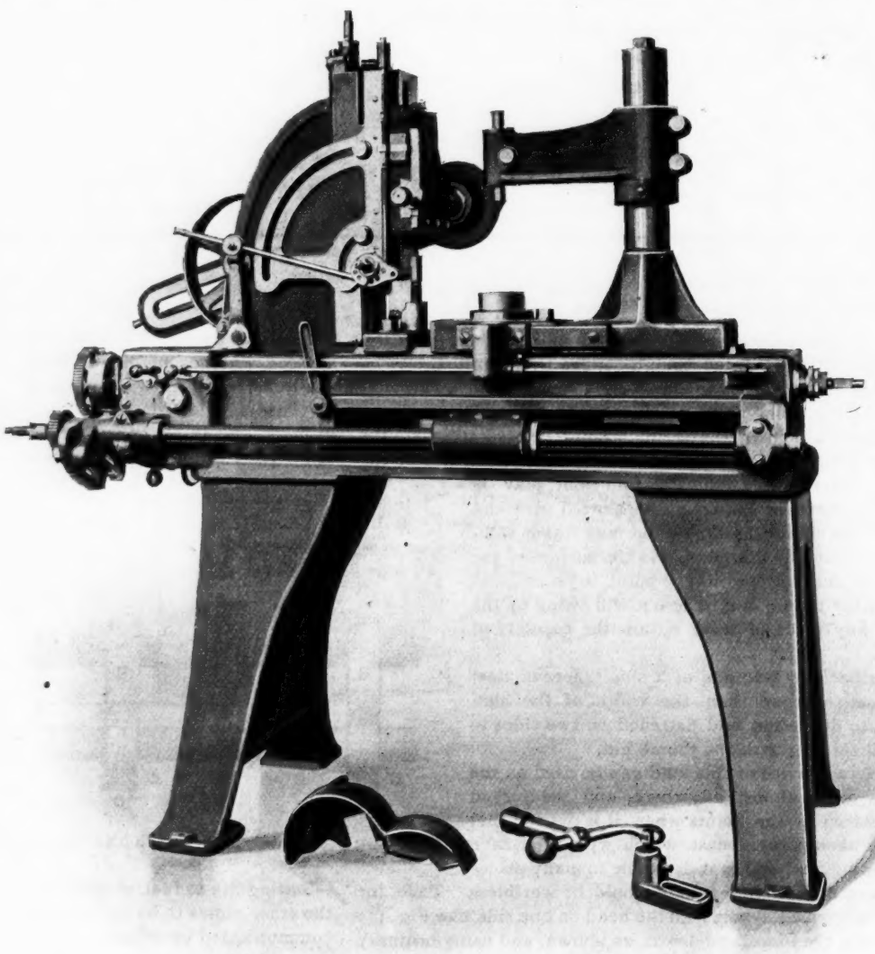


FIG. I. A NEW AUTOMATIC GEAR CUTTER.

If a wire is carrying a current of 10 amperes, which is being forced along under a pressure of 74.6 volts, by multiplying the volts by the amperes we have 746 Watts. This is the electrical equivalent of one mechanical horse power, or 33,000 pounds raised one foot in one minute. Applied to the pulley of a dynamo of a hundred per cent. efficiency, it will develop 746 Watts. This machine may be constructed so as to deliver 74.6 amperes under a pressure of only 10 volts, but the horse power represented will be the same as in the former case, because the Watts are the same. So any voltage and amperage which, when multiplied together, will produce 746 Watts, will represent one horse power, but in the transformation of mechanical energy of the engine into electrical energy of the dynamo, we of course meet with several losses, among which are friction of bearings, also friction and slippage of belt so that a one horse power en-

gine driving a dynamo would not deliver literally 746 Watts, and some of that which was developed would be necessary to magnetize its own fields; so if we take the remaining current to an electric motor, and there again transform the electric energy into rotating motion of the motor pulley, we do not get anything like one horse power developed. If we wish to obtain one mechanical horse power actually delivered from the motor, we would require an engine of 1½ horse power, and a dynamo which would generate a thousand Watts and a motor which would consume a thousand Watts. By this arrangement the motor could be made to develop one mechanical horse power.

* * *

A NEW AUTOMATIC GEAR CUTTER.

For a number of years the D. E. Whiton Machine Co., of New London, Conn., have manufactured a gear cutter of simple design intended for general shop use, and as a natural development in their experience with this class of machinery, they have recently placed on the market an entirely automatic machine, which is adapted to so wide a range of work that it is fairly entitled to be called a "universal" machine.

As seen in Fig. 1 it is so arranged that the blanks to be cut are supported in a horizontal position on a vertical work spindle, which can be adjusted to or from the cutter as required. The cutter arbor is horizontal and the cutter feeds downward into the blank.

In designing this machine, certain principles were laid down which it was believed should be followed in order to produce a machine of highest efficiency as well as of mechanical excellence. These principles were adhered to and the various parts of the mechanism were worked out in accordance with them. As a result the machine embodies the features that its designers at the start considered to be either essential or desirable.

But one driving belt is used, which requires no tightener. Every movement, either spacing or feeding, depends for its action upon the completion of the previous movement. If the blank is spacing, for example, the cutter cannot by any possibility advance into the work until the spacing is completed and has stopped, and this is equally true of the other movements. Both the feeding and spacing mechanisms are driven by positive clutches, no friction being used for either, and only one mechanism is in operation at a time, so that the full power of the driving belt is applied to either, as required. Moreover, no adjustments are required for these movements beyond the single adjustment of the stops for the travel of the carriage; and since the carriage remains at rest while the spacing is in progress, it can be set very accurately so as not to overrun more than is necessary in order to have the cutter clear the work. These are a few of the important features claimed for this machine.

Turning, now, to the constructive features, the arrangement of the cutter drive is shown very clearly in Fig. 2, taken with Fig. 3, which is a horizontal section through the uprights. Power is transmitted from pulley A, through the miter gears at D, the splined shaft shown, and the bevels at E to the arbor F. To accommodate different positions of the carriage the splined shaft is carried by the slotted arm C, which is attached to the cutter carriage, and therefore the shaft will take any position required to keep the two bevels at E in contact. The second miter gear shown upon the splined shaft in Fig. 3 is for the purpose of reversing the motion of the shaft when the rack cutting attachment is added. This is necessary owing to the peculiar construction of the attachment.

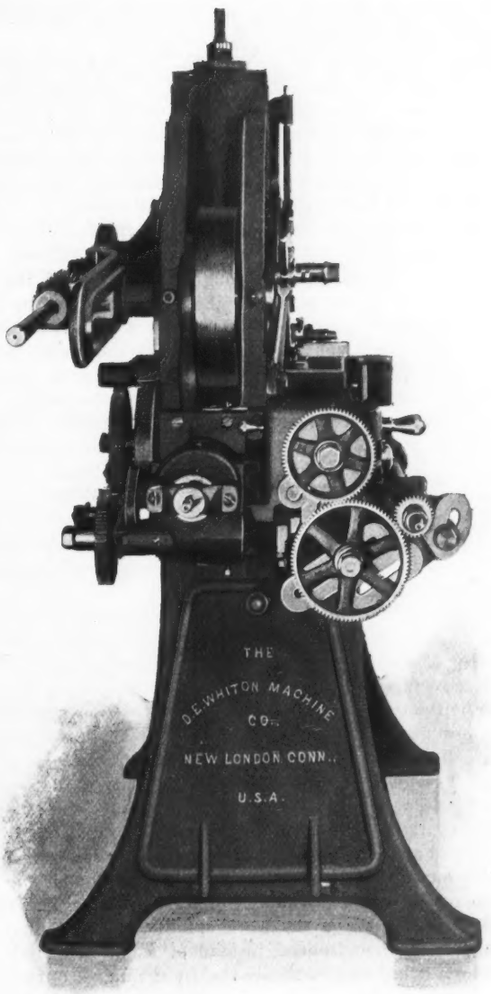


FIG. 2. END VIEW OF GEAR CUTTER.

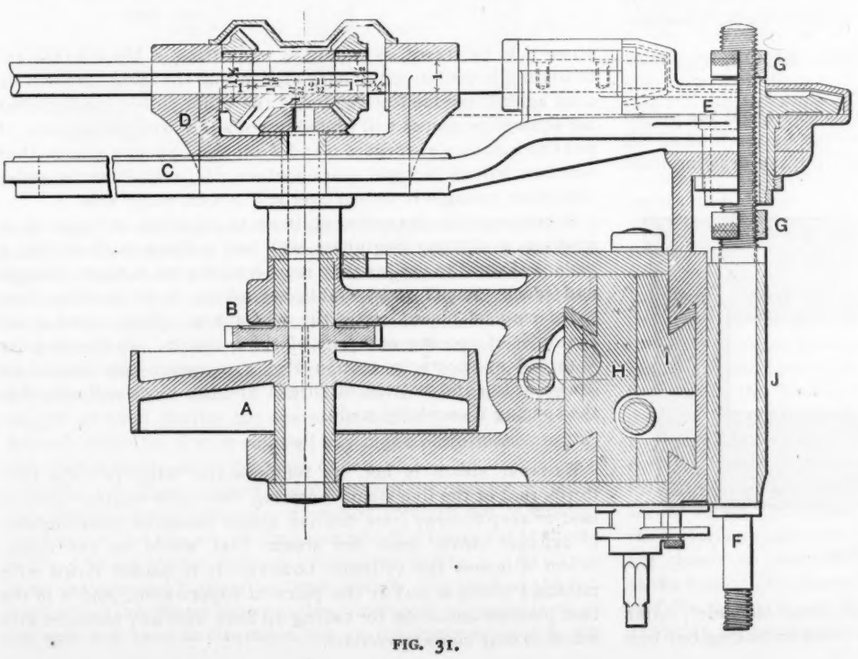


FIG. 31.

Referring to Figs. 1 and 3, it will be observed that the cutter carriage is composed of three essential parts. The first, H, is gibbed to the uprights and can be moved up or down to bring the carriage into the right position relative to the gear blank. The second, I, can be adjusted to any desired angle with the first part for cutting bevel gears, and clamped in position by the slotted sectors shown. The third, J, is gibbed to the second part, I, and feeds automatically in either direction, at any angle, after the method usually adopted in bevel gear machines. In order to set the cutter central with the work, the cutter arbor is mounted in a sliding block

which can be adjusted one way or the other to positions determined by the micrometer adjusting nuts G G.

The feed mechanism is driven from the gear B on the main shaft, through the gears seen at the left in Fig. 2, and the spacing mechanism is driven from the same source, the gears shown at the right in Fig. 2 being the index gears. These connections are therefore direct and in accordance with good mechanical principles. As previously stated, the movements are positive in their action, and the successive steps in the operation of the machine depend upon the completion of all previous steps. Tracing these movements through we find them to be as follows: When the cutter has fed down and through the gear blank the tappet on the cutter slider contacts with the lower stop, and by its own motion draws the faces of the feed clutch out of contact. Instead of then depending upon a spring to throw the clutch into contact with the quick return gearing, the same motion that disengaged the clutch releases a clutch sliding mechanism which moves the former positively into the quick return. When the cutter slider has returned to its upper position it engages the upper stop, which, as before, draws the clutch faces out of contact and causes the slider to stop. This time, however, the clutch sliding mechanism, instead of causing the clutch to engage the opposite driver, leaves it midway between the two drivers and the feed motion remains at rest until the spacing takes place.

The spacing motion is started by the last movement of the clutch mentioned above, is itself driven by a positive clutch and is interrupted at the right time by a cam, which also starts the feed motion just after it stops the spacing.

Another feature of the machine is the provision made for hobbing worm gears at one operation from blanks not previously nicked. This is accomplished by having the train connecting the spacing clutch and the main driving shaft in the same ratio as the train connecting the same driving shaft with the cutter spindle, so that the cutter and spacing device run in unison. Provision is made by which the latter can be run continuously, and this motion, in connection with the motion of the cutter spindle, can be taken advantage of for hobbing. The blank to be hobbed is placed on the work spindle, as for ordinary gear cutting, and a hob is used instead of a cutter. The regular change gears are used to secure the right number of revolutions of the blank, the feed motion is disconnected and the hob is fed into the blank by hand, or is arranged to feed by power if desired.

A rack cutting attachment can be supplied with the machine and it also has many conveniences which facilitate its use on every-day work, whether one or many pieces are to be made.

The No. 1 machine which is here illustrated, will cut spur and bevel gears to 5 diametral pitch, 34 inches diameter and 7 inches face, besides hobbing worm gears without nicking the blanks. It will divide for all numbers from 4 to 100 and all even numbers and many others to 200, besides a wide range of higher numbers.

KINKS IN THE DRAWING ROOM.

JNO. D. RIGGS.

Outline drawings are generally regarded as about the proper thing for the machine shop. But sometimes by the time all the necessary dimension lines have been put on, the drawing itself

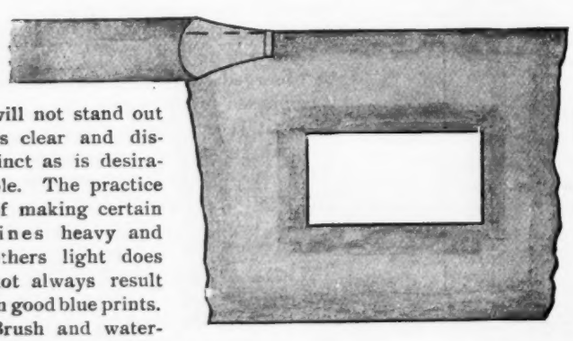


FIG. 1.

will not stand out as clear and distinct as is desirable. The practice of making certain lines heavy and others light does not always result in good blue prints. Brush and water-color tinting is out of the question—costs too much and wrinkles up a tracing so that a good print cannot be made. After going through all this and more, I have come to making out line drawings with uniform lines on all sides, then I take a carpenter's pencil, such as is used on rough lumber, and sharpen it so that it makes a mark three-sixteenths of an inch wide, or the full width of the lead; then with this go around the edges of the piece drawn, and around any holes or high parts. If the piece is small it may be shaded all over. But the thing to keep in mind is, to bring out a contrast between metal and thin air. The loose carbon can be brushed off with a sponge rubber-eraser. When working on tracing cloth I make the drawing on the glazed side and do the

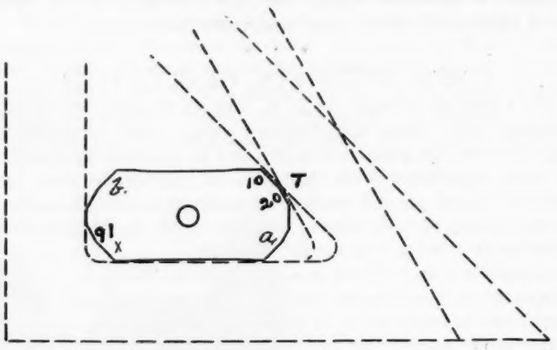


FIG. 2.

pencil shading on the dull side. This pencil shading will not show so much on the blue print as on the tracing, but will help to make a drawing clear.

A section liner that I have used considerably is shown in Fig. 2. It may be a piece cut from a cigar box with a pocket knife, and the four corners cut off at random. But I prefer to make it so that it will answer for screw threads as well. Take a piece of fine grained wood about the thickness of the triangle and cut off one corner until it will space correctly on the vertical side of triangle for, say 20 threads per inch; cut another corner for, say 18 threads and the other two for 16 and 12 threads per inch. Now, if these numbers are put on their respective corners, they will save considerable time. If this set of numbers is fitted to the 30° and 60° triangle, another set of threads may be fitted to a 45° triangle, provided it has an opening about the same size, or a second block may be used for the 45° triangle. The 45° triangle is commonly used for section lines and the 30° and 60° triangle is the only one to use where the section of a

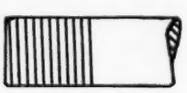


FIG. 3.

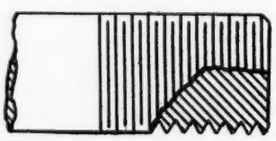


FIG. 4.

screw is to be drawn, as in Fig. 4. In fitting a block to the 45° triangle it is well to put a mark at x so that the same side will be used against the tee square; for if the other side is used against tee square the spaces will probably not agree with the figures. I put the numbers at corners a and b on the opposite side so that numbers will all be right side up where x is, and all on the under side when triangle is turned over and x is on under side.

A hole is put in the center of block to put point of finger on in pushing it along. Beginners will find a block, such as this, a little awkward to use, as they must hold the tee square, triangle and block; but if considerable sectioning is to be done, two tacks may be placed below the tee square. Figs. 3 and 4 are examples of spacing with one of these blocks. In drawing the V thread as shown in section Fig. 4, a pencil line should be drawn at top and bottom of thread and the block will attend to the spacing if carefully made.

* * *

EXHAUST steam is hot, its temperature being perhaps two-thirds that of the live steam entering the same engine, but it is best to keep it away from the live steam passages, nevertheless. If exhaust steam were dry steam, that would be one thing. When it leaves the cylinder, however, it is loaded down with moisture which is just at the point of vaporization, and is in the best possible condition for taking up heat from any surfaces with which it may come in contact.

A DIE FOR CUTTING THREADS OF CORRECT PITCH.

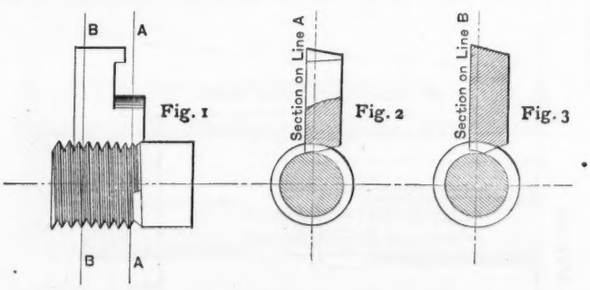
HOW THE CHASERS FOR THE HARTNESS AUTOMATIC DIE ARE MADE.—THE RESULTS OBTAINED.

For some time the Jones & Lamson Machine Co. of Springfield, Vt., have been manufacturing an automatic die (which is patented by James Hartness), for use on screw machines. While possessing several interesting and meritorious features of design and construction, the chief feature, and the one of most interest to the mechanic, is that the die is designed and manufactured with the end in view of cutting a thread of practically correct pitch. As so much difficulty is experienced in getting results with a die that are at all satisfactory in point of pitch of thread, a description of the method used by the Jones & Lamson Co. in the manufacture of their die will be of general interest.

This die formed the subject of a paper read by Mr. Hartness before the meeting of the American Society of Mechanical Engineers, and we are fortunate in being able to present in this connection and at this time a photograph of one of the machines designed for cutting the threads in the chasers, which was obtained by the writer during a call at the Jones & Lamson works, through the courtesy of Mr. Hartness.

The general features of construction of the die-head are familiar to the readers of these columns and it will be sufficient to explain that four chasers are held in position by an encircling cam, which serves to move the chasers out of or into action, as required, and to move them out of action automatically upon retardation of the die when feeding upon the work. One die-head is used for all sizes and threads from ½ to 1¼ inches in diameter, and any thread which will clear itself in the die, by inserting suitable chasers.

Some people have evidently been sceptical about the performance of this die; at least, during my call at the Jones & Lamson Company's I was asked to select a set of chasers at random in the stock-room, to see with my own eyes that this identical set



was used in cutting a thread, and to personally measure the pitch of the thread so cut. I tried a number of chasers in a die-head, and finding that they interchanged very nicely, finally selected four of one-inch diameter—U. S. Std. A bar of steel was turned up and a thread cut fifteen inches long, without the use of a lead screw. The screw, as measured with a steel scale, may have been inaccurate in pitch to the extent of $\frac{1}{100}$-inch per foot; but not more than that. I will not affirm that there was no sleight of hand during the operation, but if there was, it was done so skillfully that it eclipsed any stage performance in this line that it has been my pleasure to see.

In Fig. 1 is shown one of the chasers in the position which it occupies in cutting a thread. A section through AA of the forward end of the chaser and the screw which is being cut is shown in Fig. 2, and a section through BB is given in Fig. 3. As shown in an exaggerated manner by these sections, the teeth at the forward end of the chaser have a cutting clearance, while the teeth at the back end have no clearance, but on the contrary bear at the heel and serve to lead the die. They thus act as a sort of nut which follows and controls the cutting edges of the chaser, and not only relieve the cutting edges of the labor of feeding the die forward, but if the pitch of the teeth is correct must necessarily ensure a correct screw.

THE METHOD OF CUTTING THE TEETH.

The teeth of the chasers are milled with milling cutters of large diameter having teeth ranged in annular rings, and not in the form of a thread as would be the case if a tap were used. Both the cutter and a chaser are shown in position in the machine in Fig. 4, where the milling is done. In order to get the cutting clearance for the forward teeth of the chaser and the bearing

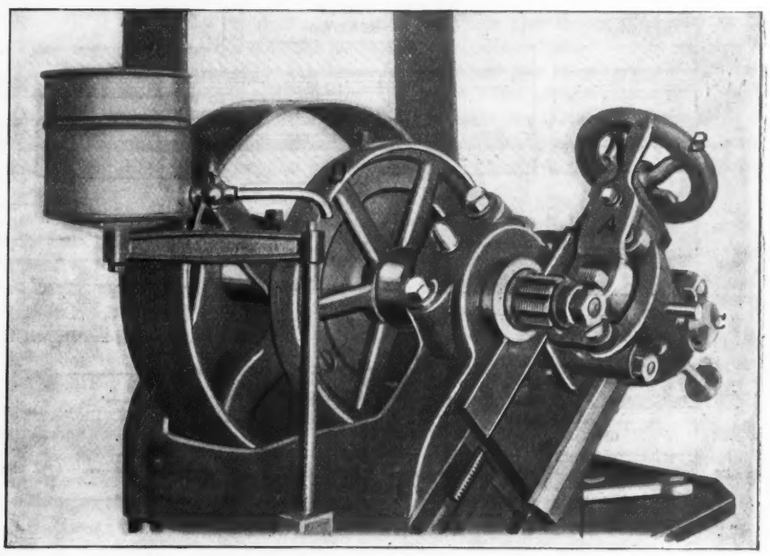


FIG. 4. MACHINE FOR MILLING CHASERS.

on the heel for the teeth at the back end, the cutter is set at an angle in milling the chasers as illustrated in Fig. 5. Here the same view of the chaser and screw is shown as in Fig. 2. The cutter is indicated by the dotted lines and it will be seen is set at an angle, the line *a a*, representing the forward edge of the cutter and the line *b b*, the rear edge of the cutter. With the cutter set in this way its forward center falls at F and its backward center at B on the line *x y*, and the highest point of the forward edge of the cutter as it enters the chaser is at *c*, which gives a clearance for the cutting teeth of the chaser. On the other hand, the highest point of the rear edge of the cutter as it enters the chaser is at *d*, thus cutting the teeth deeper on the left hand side of the chaser, but not so deep on the right side, which makes the threads low enough to bear on the screw on this side and lead the die.

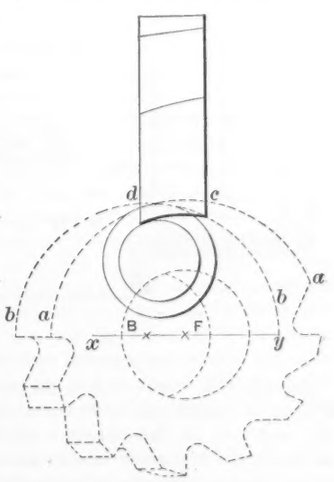


FIG. 5.

In doing the milling in the machine the axis of the milling cutter always remains in the same position while the chaser itself is tipped to bring it right relative to the cutter. The adjustments for the chaser are effected by the handle A in Fig. 4, which serves to set the chaser at any desired angle with the axis of the cutter, and the micrometer screw C, which is used for tipping the chaser so that the teeth can be cut to any desired depth at the heel. The chaser is fed into the cutter by hand wheel B, and the depth of cut is regulated by a micrometer screw, not shown in the photograph.

When the chasers are in position in the die-head the teeth of each successive chaser must lead the teeth of the preceding one by one-quarter of the pitch, so as to follow the spiral line of the screw thread. It is necessary, therefore, to be able to set the milling cutter at exactly the right distance forward or back before milling the teeth in the chasers. This is provided for by setting the cutter spindle out or in by means of a micrometer adjustment, the graduated wheels of which are visible at D.

An elaborate table of readings for the different adjustments has been prepared to assist the workman in setting the machine for different pitches and threads and the whole process appears to have been worked out with great nicety in each detail.

AN EXAMPLE OF SHOP WORK.

HOW A NUMBER OF SPECIAL INTERCHANGEABLE SPINDLES WERE MADE—COMMENTS INVITED.

Not long ago two dozen special machines were built and the problem was to make all of the parts interchangeable so far as that could be accomplished without increasing the cost of producing that one lot of machines by time and money spent on special tools and fixtures.

When a special tool was not an absolute necessity, it was not to be made unless it was evident that it would save enough time

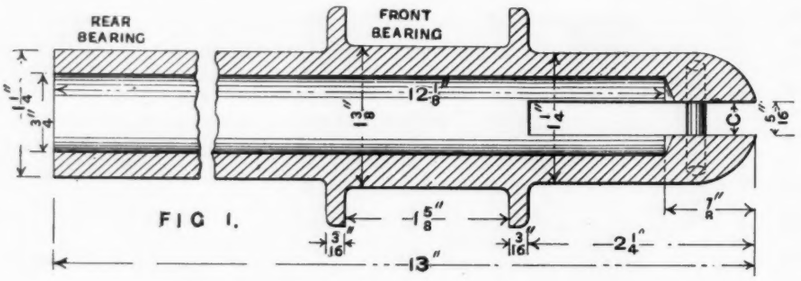


FIG 1.

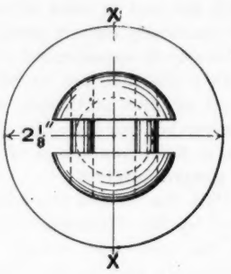


FIG 2

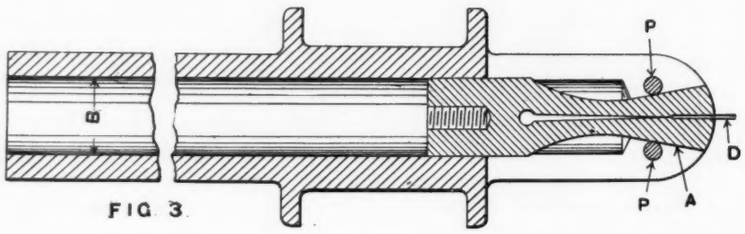


FIG 3

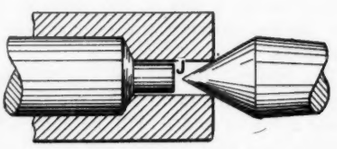


FIG. 10.

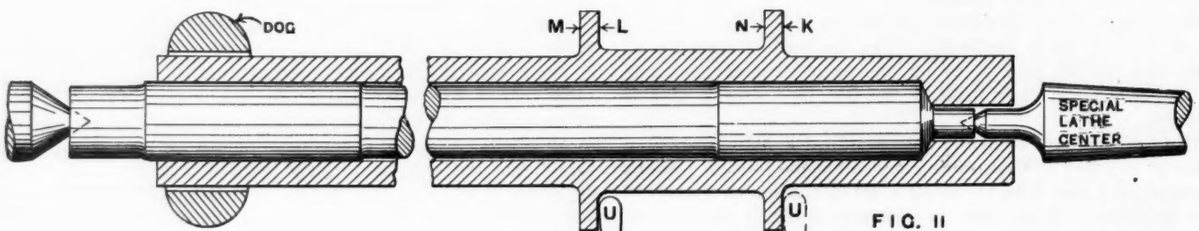


FIG. 11

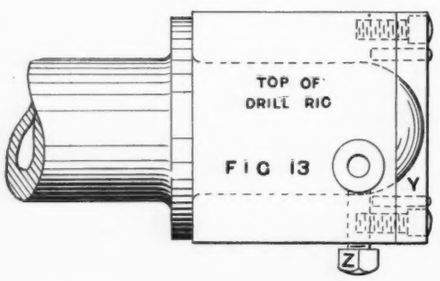


FIG 13

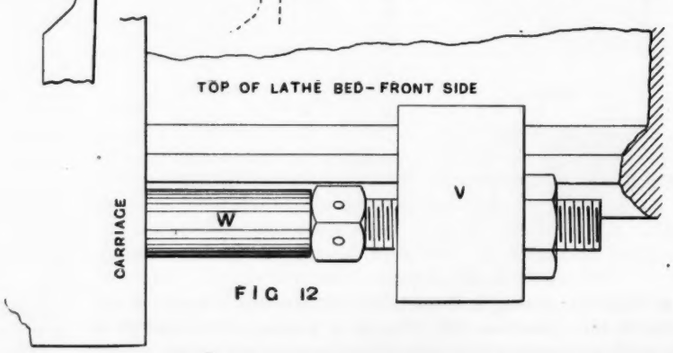


FIG 12

THE ERRORS OF THE CHASERS.

Barring poor workmanship, the possible errors in this method appear to be two—an error in the milling cutter, due to hardening, and one in the chaser from the same cause. In reality, however, the first error is eliminated by setting the cutter with its axis making a greater or less angle with the chaser, which it will readily be seen will alter the pitch of the chaser teeth slightly, if it is necessary to do so, in order to obtain the correct pitch.

As to the second error, Mr. Hartness states that the hardening of the chasers takes place under such favorable circumstances that it is not appreciable. The chasers are heated in a gas furnace and hardened in an oil bath at 480 degrees temperature and the fact that the teeth are cut with a sharp milling cutter makes any internal strain from that cause, which would be liable to make trouble, quite improbable. F.

to pay for itself on the 24 machines alone. But the spindles and their parts had to be made interchangeable and accurate, regardless of cost, although preference would be given the cheapest practical device.

The tools and methods used in making the spindles are the subjects of this paper, and the reader is requested to bear in mind that the equipment of the shop was about such as one could expect to find in an ordinary machine shop of about 20 men; and remember also that these notes are written to give the young men something to think about, by describing how the work was actually done, rather than telling how it should have been done; comments of that nature and criticisms are invited.

The spindles were made from round steel bars 2¼" in diameter, cut up so as to allow about ⅛ of an inch in length for finish, then centered and a chip run up on the ends far enough for the

center rest, making them all one size for convenience in boring. Two views of a spindle are shown in Figs. 1 and 2, while Fig. 3 is a sectional view with jaws A in place.

The important points were that the hole, B, should be uniform in size, straight and true with the outside, and the slot C through the nose of the spindle exactly in the center, so that the jaws could be interchanged or turned over and still hold the piece D, so that it would run perfectly true when the spindle revolved in its bearings. This was necessary because jaws for various sizes were to be made and fitted to a "sample," and then changed about and used on the different machines as required; and for this same reason it will be seen that the slots C had to be all of one width, and the two pins, P P, in each spindle had to revolve in the same circle and be equidistant from the center.

For the sake of simplicity, I have shown the jaws somewhat different from the originals, but the requirements are exactly the same.

As the hole was only ¾ of an inch in diameter and 12⅛" deep, the outside was finished and the slot made after the spindles were bored, as the easiest method of securing the desired accuracy, although the hole did not extend all the way through.

As the distance from the bottom of the hole B through to the end of the spindles was only ⅞ of an inch, it was believed that an arbor with its end reduced could be used to advantage in connection with a small hole through the part to be slotted, although it could not exceed $\frac{5}{16}$ of an inch in diameter. It was not deemed practicable to have the arbor fit in this small hole, and instead of the test bar process, the small hole J was worked through from the inside with the tools in Figs. 6 and 7.

After spotting the ends, both B and J were drilled and reamed in the center rest at one setting. The rose reamer, Fig. 5, left the hole B, about .003 of an inch small, and it was finished with Fig. 9, by careful hand reaming. The hand reamer was guided by its carefully ground shank, and the enlarged part of the shanks immediately following the small drill and reamer filled the hole B and determined the proper location of the small hole.

The next operation was to put the spindles on centers and rough them out. On account of the quantity of stock to be removed, the rough turning should have been done before the final reaming of the hole B, but no appreciable change was noticed; and to reduce the evil effects of a crooked hole to a minimum, the arbor was made with only a short bearing near each end. Its small end was also made short enough to leave little danger of its getting sprung, and incidentally, to avoid contact with the regular lathe center during the rough turning, which needed the stiffness obtained by inserting the lathe center into the hole itself, Fig. 10.

FIG. 5.

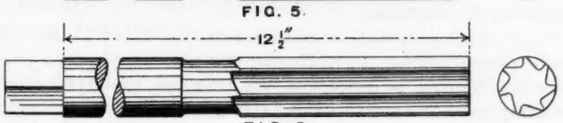


FIG. 9.

The special lathe center used for the finish turning, shown in Fig. 11, needs no description, but some of the apprentices might want to know how the flanges were located in proper relation to the bottom of the hole. In finishing the outside, the front side of flange K was taken as a point to work from. The arbor was put on the centers and after properly setting one of the stops V and the tool U, they were adjusted to face up K, in its relation to the shoulder on the arbor. Then the arbor was pushed in against the bottom of the hole in a spindle and put in the lathe and K finished. Gauging the distance by plug W, Fig. 12, the carriage was moved to the left sufficiently to finish the face L, Fig. 11, setting the other stop for finishing M, then using the plug in the same way as before, the carriage was moved to the right and N finished; and the same operation repeated on each of the spindles without changing the adjustments, completed that part of the work. One of several other ways to obtain the same results without the use of the stops would have been to lock the carriage in the proper place and finish K on each of the spindles and work from that by measure to finish the rest.

All of the finish turning was done with the arbor and special center, except rounding over the end—the center rest and a forming tool were used for that, with the arbor inserted to receive the live center.

Using the spiral head of the B. & S. milling machine with a plug center fitting into B, and the front bearing held in the center-rest, the slot was milled half way through, first on one side and then the other, so that any error in locating the slot on one side would be largely corrected by a duplicate error in the opposite direction on the other when the work was indexed over.

A jig, Fig. 13, for the two pin holes in the nose of the spindles was the next in order. It was simply a square block with a hole for the drill and reamer bushings, and a bar Y, across the hole into which the noses of the spindles were all turned to fit. The face K, of the flange was clamped against the jig which determined the location of the pin holes in one direction. The bar prevented the slot closing under the pressure of the drill and served as an index, and of course had to be just the right height; also parallel to the base of the jig and at right angles to the holes

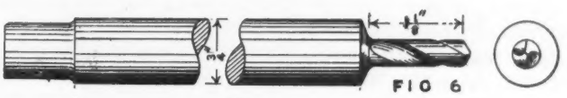


FIG 6

FIG 7.

in the bushings, or the pin holes would not have been square with the slot. To prevent the drill and reamer crowding away when they struck the rounded surface of the work, the bushings were filed off on one side to fit down around the spindles and support them; and pieces of soft steel of the same shape were inserted to fill the hole on the under side for the same purpose.

When all was ready, one pin hole was drilled way through from the top, the drill bushing removed and the reamer bushing put in and the hole reamed. After removing the spindle and filing off the burr, it was turned over and put back into the jig, another soft block inserted in the hole on the under side and the second hole drilled and reamed like the first.

To go into the details of making the drill jig would make these notes unpardonably long, so I will leave that as a problem for the readers of this paper and ask them to describe how they would proceed in making it. A. L. G.

* * *

THE comparative large number of recent elevator accidents directs attention to the character of the automatic clutch devices which are intended to prevent the falling of elevators when the gearing of the hoisting ropes breaks. In spite of the fact that good engineering talent is concerned in this branch of transportation there seems to be an opportunity to offer a suggestion to the effect that it is not safe to rely upon the action of an automatic device which does not operate frequently. One of the fundamental principles in railroad signaling requires a failure of the apparatus or sticking of the parts to give a danger indication, which directs attention at once to the apparatus and compels investigation. This ought to be brought into elevator practice in such a way as to render it impossible to use the elevator if the safety devices are not in working order. It is unquestionably easier to make this suggestion than to apply it, but this is believed to be the direction in which the safety devices of the future should be sought.—*American Engineer.*

* * *

ACCORDING to the *Electrical Review*, the long suffering public will shortly be deprived of the pleasure of receiving a stream of water down the back of their necks every time they enter or leave an open car during a shower. Electrical experts are pretty bright men, and eave gutters are pretty common affairs in the house building line; but it has been left for a recent inventor to be bright enough to think of using gutters on open electric cars and employing the brass tubes now used as hand rails for carrying the water from the roof to the ground.

REDUCTION IN COST OF STEAM POWER FROM 1870 TO 1897.

ABSTRACT OF A PAPER READ BY F. W. DEAN BEFORE THE NEW YORK MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

In the year 1870 the most economical steam engine in use in mills was the Corliss simple condensing engine which used nineteen or twenty pounds of steam per horse-power per hour. Previous to that time compound engines had been used in England in mill practice, and simple engines had in many cases been changed to compound. In this country compound pumping engines had been used to a very limited extent, notable examples of which were the Worthington direct-acting duplex compound engine, the Morris engine at Lowell, the Leavitt engine at Lynn, and later the Pawtucket pumping engine, built by Geo. H. Corliss, which used less than fourteen pounds of dry steam per indicated horse-power per hour.

While these engines are not mill engines, they influenced the practice of builders of mill engines, and can properly be considered with them. Pumping engines have heretofore been the leaders in economy, but at present the best pumping and mill engines are practically equally economical.

Of course, the greatest single step in economy was the introduction of the compound engine.

At the present time we may cite the Louisville pumping engine and several mill engines, one or more at Grosvenor-Dale, Conn.; Natick, R. I.; West Boylston, Mass.; Berkley, R. I., and Lawrence, Mass., as being about on a par, and representing the best commercial economy.

REDUCTION FROM 16½ TO 14 POUNDS OF STEAM.

In 1873 the most economical compound engines used about 16½ pounds of steam per indicated horse-power per hour, as shown by the tests of the Lynn and Lawrence pumping engines, which then established new records for duty. Improvements in methods of using steam were made until it is now as easy to design an engine to use less than 13 pounds of feed water per horse-power per hour as it was to use as little as 16 pounds in 1875.

At this date steam jackets were common and were used in all engines which gave the most economical performances. The steps, however, that lowered the steam consumption of compound engines from 16 pounds to 14 pounds per indicated horse-power per hour were largely the introduction of a cut-off on the low-pressure cylinder and a reheating receiver between the cylinders. Although the reheater was invented by the late E. A. Cowper, of London, in 1862, so far as I know, it was first used in this country by E. D. Leavitt in his engines for the Calumet & Hecla Mining Co., and is regarded by him as one of the most important causes of the economy of his engines.

These features appear to have been the principal means of lowering economy to 14 pounds of steam; but to what are we to attribute the step to 13 pounds?

THE 13-POUND MARK.

Clearance is well known to be an important factor, and its reduction, especially in the last cylinder of a series, is important for economy. It is receiving constant attention from careful designers, and its reduction is a constant source of gain. The 13-pound mark has also been reached by an increase in steam pressure with resulting increase in the number of expansions. In some cases a reduction in the size of the high-pressure cylinder has doubtless contributed toward economy, by means of which smaller surfaces are exposed to the boiler steam than would otherwise be the case. This carries with it a proportional reduction of initial condensation in the cylinder which is most prolific in this cause of waste.

Still further, the 13-pound mark has, in general, been attained by engines which have a low-pressure cylinder larger for the work to be done than is commonly the case, so that the mean effective pressure referred to the low-pressure cylinder is in the vicinity of 21 pounds. There are occasional exceptions, as in the case of the Louisville engine, which worked with a mean effective pressure referred to the low-pressure cylinder of 25 pounds. Such cases are exceptional, and their economy can be attributed to great perfection of detail.

It will in general be observed, however, whatever may be said of other causes, that most of the extreme cases of economy are those in which a good vacuum has been maintained. This leads me to say that the importance of good vacuums is often not appreciated, and that air pumps and condensers are as often too small.

There is a strong tendency nowadays to underrate steam jackets, but I believe that in every case where they have been wasteful, or where their economy is indifferent, at all events with ordinary speeds, an examination would show that the jackets are air-bound, water-logged, blowing through traps, or that the jacket piping is bare, and thus steam for heating the building is charged to the engine. Such an arrangement of pipes can furnish but indifferent material for giving up latent heat to the working fluid within the cylinders, and is, in fact, absurd.

The effect of reheaters in drying out steam which issues from a preceding cylinder and in superheating it to 60 degrees or 90 degrees, as is often the case, for use in the next cylinder, cannot be otherwise than advantageous, for, as Professor Thurston shows in his paper of 1894 before this Society, heat so added to the working fluid saves much more steam than was condensed to liberate this heat.

While these considerations are very general, they are necessarily so, for no one can attribute to any one of the features named its proper effect. Moreover, their combinations are very varied.

Whatever may be said pro and con on this subject, it cannot be denied that the best results have been obtained from engines equipped with jackets and reheaters.

Considering economies effected, it is safe to say that, without including triple-expansion engines, steam economy has steadily decreased from 20 pounds to 12½ pounds per indicated horse-power between 1870 and 1897. This corresponds to a saving of 37½ per cent.

There are also economies to be obtained from the use of vertical engines. These come from reduction of friction, reduction of repairs to cylinders and pistons, and diminished cylinder oil consumption. It would not surprise me if there were a net saving of 5 per cent. by reduced friction of a vertical compound compared with a horizontal engine.

THE IMPROVEMENT IN BOILER ECONOMY.

What is there to be said concerning boilers within the period that we are considering?

The horizontal return tubular boiler is still the standard of the country, and will probably so remain. It is cheap, and, if properly built, it is safe. As its tube-heating surface can be effectively blown with steam with the certainty that the jet will strike every part thereof, and as, furthermore, its tubes can be effectively scraped at any time without taking the boiler out of service, it must necessarily be more economical than any of the numerous water-tube boilers which are now being introduced. The fire services of the latter can only be indifferently blown, and they cannot be scraped at all unless the boiler is cooled down, and in general it cannot then be done with anything approaching thoroughness.

There is scarcely any improvement to be noted in the horizontal return tubular boiler during the last twenty-seven years as far as economy is concerned, but I believe that grates have been improved to a measureable extent, resulting in an economy of perhaps 2 per cent.

My own experience teaches me that the internally fired boiler, either of the locomotive or vertical type, will save under equal conditions some 7 per cent. of coal compared with the horizontal return tubular boiler, besides causing an important economy in doing away with brickwork.

Within twenty-seven years economizers for heating feed water in smoke flues have become common. Although subject to a rather large depreciation, in the general case they will save about 7 or 8 per cent of coal.

GENERAL SUMMARY.

Summing up the various items that have been mentioned, the following may be presented as the economies of the period from 1870 to 1897:

Saving due to compounding, jackets, reheaters, higher pressures, and greater expansions	37 per cent.
Due to vertical engines	5 " "
Due to vertical internally fired boilers	7 " "
Due to economizers	7 " "
Due to improved grates	2 " "

So far the only steam engine considered is the compound engine. This engine has recently been found capable of utilizing the higher pressures much more economically than was formerly suspected. It has therefore diminished the advantage of the triple-expansion engine to such an extent that the latter has met with something of a setback. I believe, however, that the triple engine is still to be common when pressures begin to exceed 160 pounds of steam, and its undoubted advantage at sea gives evidence that it will be no less on land. Within a year or two an interesting and instructive comparison can be made between two pumping engines, one compound and one triple, both to use 185 pounds of steam and designed on the same lines by Mr. Leavitt.

It seems probable that the relative economies of the compound engine, using 160 pounds, and the triple, using 185 pounds of steam, are to-day represented in the very best practice by 12¼ pounds of steam and 11¼ pounds of steam respectively per indicated horse-power per hour. This corresponds to a saving of 8.16 per cent., which is a paying saving.

THE EFFECT OF SUPERHEATED STEAM.

The future, so far as we can now see, offers us highly superheated steam for further means of economy. The technical papers have frequent accounts of the use of such steam in Germany, and published tests show that a small Schmidt "motor" has used 10.17 pounds of steam per indicated horse-power per hour. It would seem that we have a right to anticipate in the early future a steam rate of 10 pounds by means of superheated steam in the best designed engines. Compared with the lowest rate thus far mentioned this corresponds to a saving of 11.11 per cent.

We have also in anticipation the use of very high steam pressure and quadruple-expansion engines as built experimentally at Cornell University and described by Professor Thurston last year before this Society. If, however, steam can be so highly superheated that expansion in one cylinder will not cause condensation, nor even the saturated condition until the time of exhaust, as was the case in the Schmidt motor, extreme economy may be obtained without resort to the multiple-expansion engine.

The economies thus far mentioned relate to improvements in engines and boilers; but one of the greatest economies results from the low cost of coal at present in Lowell, Lawrence, and similarly located towns, which makes a reduction of from $7.10 per ton for anthracite coal, in 1870, to $3.85 per ton for bituminous coal, in 1895.

ACTUAL REDUCTION IN TOTAL EXPENSES.

Mr. Dean then considered the actual cost of a mill steam plant of 1,000 horse-power, such as would be found in a Massachusetts mill town away from tide-water. He stated that the very best steam plant of this power, 27 years ago, including a pair of simple condensing engines using 20 pounds of steam, boilers evaporating 8 pounds of water on coal used, buildings, chimney, and all accessories, cost $70 an indicated horse-power. The interest on this at 6 per cent., depreciation at 4 per cent., repairs at 2 per cent. and insurance at 1 per cent. amount to a total of 13 per cent., or $9.10 per horse-power per year. To this should be added $24.40 for coal, and $4.64 for attendance and supplies, making a total of $38.14 per horse-power per year. The very best plant of 1,000 horse-power can be installed to-day, complete, with compound engine using 12.5 pounds of steam, evaporating 9 pounds of water on total coal used, economizers, and all accessories, for $57 per indicated horse-power. Such a plant can run on 1.4 pounds of coal per indicated horse-power per hour for total coal consumed. The fixed charges amount to 11½ per cent., or $6.55. Coal amounts to $7.41; attendance and supplies, $3.88; total $17.84 per horse-power per year.

These results give a saving in 27 years in first cost, 18.6 per cent.; saving in 27 years in operation, 53 per cent.

On the supposition that superheated steam can reduce the steam consumption to 10 pounds per indicated horse-power per hour, and that the combined efficiency of boilers and economizers is not affected thereby, the cost of installation of 1 horse-power can still be taken at $57:

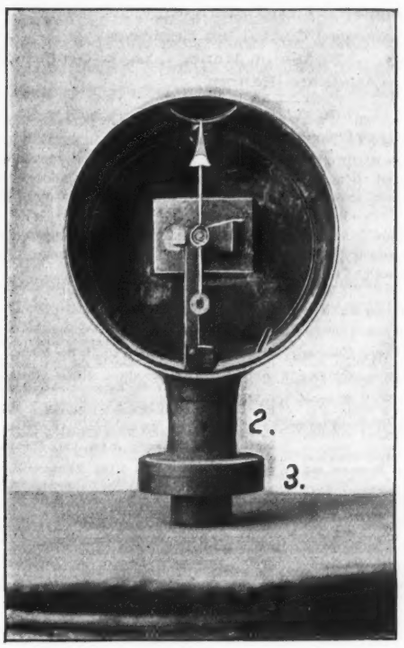
The cost of coal per I. H. P. will be:	$ 5.88
Other charges	10.43
Total	$16.31

This makes a saving of yearly charges, compared with the best present plant, of 8½ per cent.

THE FIRST STEAM GAUGE.

We publish herewith a description and photograp of what is claimed to be the original steam gauge, or at least one of the first and of the same type as the first one, which was invented and made by the late Sidney Smith, of Nottingham, England. The description is taken from "*The Mechanical World*," and the photograph, which shows the gauge with the face removed, was kindly furnished by Messrs. Sidney Smith and Sons, of Nottingham.

The diameter of the face is 6½ in.; the depth of the case 6¾ in.; distance from the top of the case to the bottom of the flange 9½ in. With the exception of the flange the rest of the case was made in *thick wrought* brass. The dial is silver-plated. The total length of the instrument, including a ½ in. iron syphon, is 23 in.



THE FIRST STEAM GAUGE.

It is widely known that this first steam gauge was fixed up and personally superintended in accordance with instructions received from George Stephenson, by the inventor himself — the late Sidney Smith —just 50 years ago. We have to-day come across, amongst other old papers, a memorandum relating to the fixing of this steam gauge, which we think will be of historical interest to your readers.

"Early in the morning following the erection of the gauge the two nephews of George Stephenson (Messrs. Hindmarsh and Langham, who had then the management of the Tapton Collieries) came to see the gauge at work, and as the pointer was moving round the dial, indicating the rise of steam in the boiler, these two young gentlemen put their ears to the gauge in order to ascertain if it was ticking, as in the movements of a clock."

Referring to the photograph it will be seen that the gauge is of the diaphragm type. The diaphragm is placed between the flanges at 3, and connecting with the rack and pinion which turn the hand is a rod passing through the neck 2 to the diaphragm. The circular spring 1 is supported at the upper part of the case and the lower part is fastened to the rack and counteracts the weight and inertia of the moving parts.

The following, taken from one of Sidney Smith and Sons' circulars, and said to have been written by George Stephenson, is of interest.

"A most important invention has been submitted to me for my approval, patented by a Mr. Smith, of Nottingham, and intended to indicate the strength of steam in steam engine boilers. It is particularly adapted for steamboats, and can be placed in the cabin, on deck, or on any other part of the vessel, where it may be seen by every passenger on board. It may also be fixed in the office of every manufactory where a steam engine is used at a considerable distance from the boiler. The indicator is like the face of a clock, with a pointer, making one revolution in measuring from 1-lb. to 100 lbs. upon the square inch of the pressure of steam. It is quite from under the control of the engineer, so that its indications may be relied upon, and the construction is so simple that it is scarcely possible for it to get out of order. The numerous and appalling accidents which have occured from the bursting of steamboat boilers have induced me to give you these observations, which I think desirable to be laid before the public."

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JANUARY, 1898.

THE table of contents for this number will be found directly following the reading matter. In its new position more space will be devoted to it than heretofore, thus making it more comprehensive.

* * *

MANUFACTURERS, either domestic or foreign, who intend building new plants or adding to their present ones, who are looking for special tools, or who want to buy or exchange machinery, are offered without charge the use of the information on these subjects accumulated in this office. Such inquiries are not published without the special request of those who send them.

* * *

IT is a little curious that locomotive builders supply no facilities for handling heavy details about their machines. If a man has to take down the big end of a connecting rod for any cause, he has to hunt up a shore somewhere to hold the end of the rod after it is disconnected, when if the builder had put a small eye-bolt in the running board over the rod and supplied an obvious hook, or sling, made of half-inch round iron, everything would have been lovely and no shores would be needed.—*The Engineer* (New York).

Locomotive builders are not the only guilty ones in this respect. The lack of eye-bolts and eye-bolt holes is a common fault with heavy machinery of all descriptions, so far as our experience goes, to which anybody who has put in time on the erecting floor will probably testify. The matter is not always remedied on the erecting floor, however, because with the cranes and tackle that are generally at hand in the shop the pieces *can* be handled, eye-bolts or no eye-bolts. The outside man is really the one who has to suffer. What a blessing it would be if every draftsman had to spend a few months on outside work erecting heavy machinery! He would learn a lesson about eye-bolts that he would never forget, and his drawings would thereafter call for tapped holes for the purpose, and plenty of them.

THE USE OF THE SLOTTER.

The slotter occupies a peculiar place among machine tools. Since it originated, many tools that were not known or thought of have come into extensive use in nearly every shop, and some of the old stand-bys, like the lathe and drill press, have been modified and improved in design and adapted to many special uses. The slotter, however, seems to be about where it was at the start. It is quite possible that more slotters are sold at the present time than ever, but it is certain that the sale of other tools has increased to a greater extent, so that relative to these it has fallen behind. Moreover, the slotter has not been adapted to special uses, and in fact its design has not been changed in any important particulars, except in the strengthening and stiffening of the parts, such as is demanded in any modern tool.

On the face of it this seems rather strange, because there are certain features about the slotter that look very attractive, and we have even heard predicted that if it were redesigned in some of its details and put on the market as a "vertical shaper," instead of as a "slotter," it would encroach upon the field now occupied by the horizontal shaper, using, of course, a planer tool in the tool-block at the extreme end of the cutter bar, instead of the usual slotter tool.

The advantageous features of the slotter are first that the lay-out of the work is always visible, the line to be worked to being on top where the tool begins to cut instead of where it finishes the cut as in the case of the shaper; and secondly, that there are three feeds—longitudinal, cross and circular—all with a wide range.

The mere fact, however, that the slotter has not made more headway as a tool for general shopwork indicates that these advantages are not sufficient in themselves to bring it into common use. There are at least two points that are against it. First, and of minor importance, is the weight of the cutter bar, which tends to take up the lost motion of the joints in the wrong direction, causing noisy running and which necessitates counter-balancing, thus adding to the inertia of these parts. Secondly, the cutting has to be done at right angles to the table on which the work is set and for reasons which it will not be necessary to enumerate here, but with which every planer hand is familiar, as good results cannot be expected by setting up in this way, as when the table and cutting stroke are parallel. This objection might be overcome by using a knee or a vertical table to bolt the work to, but a more inconvenient arrangement could scarcely be imagined. With the horizontal table and the vertical stroke of the tool, also, a good deal of time must be wasted in setting the work when it is necessary to plane to a line or parallel to a surface; it cannot be set correctly without trial, as it often can on the planer or shaper.

These disadvantages of the slotter appear to be inseparable from it, and partially explain, at least, its present position. For the slotting of interior surfaces and the planing of such exterior surfaces, as for one reason or another cannot be done advantageously on the planer or turned in the lathe, and where the pieces are of medium or large size, the slotter is a necessity, and it hardly seems probable that for this work it will ever be superseded. On small work, although a useful machine, it is at a disadvantage, because a small and slender tool must often be used

which will not stand a heavy feed; besides, such work is often duplicate work and can generally be done cheaper, either by broaching or on the milling machine.

* * *

AFTER a man has spent some time on large work in the shop, mistakes which he makes on small work do not weigh so heavily on his mind as before; they do not seem so important. In a measure, therefore, large work may tend to make a person careless. It unquestionably tends to give him confidence, however, which more than offsets any other effect. When one can lay out a heavy job and then wade into it with an inch cut and an eighth of an inch feed without feeling uneasy, he has gained a confidence in himself and in his ability that will be invaluable to him in almost any work that he may take hold of.

MAKE IT PLAIN!

It goes without saying that if a book or an article is to serve a useful purpose it must be read by somebody; and if it is of value the greater the number of people who read it the more useful will be its mission.

In mechanical literature, if a book or an article is to be read it must either be written so that the average man of a mechanical turn of mind can comprehend it without too great an expenditure of brain power, or else it must be of such worth and contain so much valuable information that mechanical men will feel that they cannot afford to do without it, and will put forth special efforts to obtain the information, however deep it may be buried in mathematics or cloudy explanations.

There are probably a few authors with sufficient ability to bring their writings into the latter class, but they are exceptional, and it would show no lack of scholarship if even they should present what they have to say so that the men who are doing the actual machine building and designing can read and understand. As for others, their works must necessarily command very little attention unless they are written in this way.

Last month we pointed out that while the higher mathematics are useful and in fact are necessary in the derivation of certain engineering formulas, they are not required in the application of such formulas to practical work. Why not, first of all, put such formulas into shape so that they can be used, and then illustrate them with examples and clear explanations?

One of the advantages of a college education is that it enables the recipient to obtain information from books that men who have not had this training have difficulty with. A college graduate *can* do this, but we believe we are right in saying that the average college graduate doesn't like to do it any better than anybody else. The plain fact of the matter is that most men who amount to anything in actual constructive work become so absorbed in practical details that they have little time or disposition to keep in training for problems in mathematics, even if they were in training at the start.

We can think of no reason why anything that is written with the expectation that it will be read should not be put in clear and simple terms. It is our opinion, at least, that it should be, and we submit it for the consideration of our readers and as a suggestion to our contributors. If there are any who do not agree we shall be glad to hear from them—but please state reasons.

* * *

THE crowning achievement in the mechanical world in 1897 was the invention of the Gilderfluke locomotive. Unlike many good things, it needs no pushing along; it goes itself at the rate of 119 miles an hour and saves 112 per cent. of the fuel on the way, besides having 102 other money-saving devices that all operate at the same time. The inventor, Eli Gilderfluke, has recently been introduced to the public by *Locomotive Engineering*.

THE MEETING OF THE MECHANICAL ENGINEERS.

The annual meeting of the American Society of Mechanical Engineers, which was held at the society's house in this city, from November 30 to December 3, was attended by over 600 members and guests—the largest attendance on record. At the opening session the retiring president, Mr. Worcester R. Warner, delivered the annual address upon "The Telescope, Considered Historically and Practically." This address was one of the most enjoyable features of the various meetings and bore evidence of the scholarly acquirements of its author and of his intimate knowledge of the apparatus in the building of which his firm of Warner & Swasey have become famous.

At the business meeting the following officers were reported elected for the ensuing year by the tellers: for President, Chas. Wallace Hunt, New York; for Vice-Presidents, to serve two years, John C. Kafer, New York; David R. Fraser, Chicago; Walter S. Russel, Detroit, Mich.; for Managers, to serve three years, James B. Stanwood, Cincinnati, O.; H. H. Suplee, Philadelphia; George Richmond, New York; for Treasurer, Wm. H. Wiley, New York. Mr. Hunt is the founder and president of the well-known C. W. Hunt Co., manufacturers of conveying and power transmission machinery, and has been prominent in mechanical and scientific circles for many years.

At the same meeting, Mr. Gus. C. Henning, who was sent by the society as delegate to the International Conference on Standard Tests and Testing Materials, which was held at Stockholm last summer, read his report. An American section of the international organization is to be formed and hereafter the proceedings are to be published in English, so that much valuable information relating to standard tests will, in the future, be available to a larger body of students and general readers. In this and at a subsequent meeting, a great deal of time was taken for the discussion of a report made by the committee appointed to revise the code for boiler tests, adopted by the society in 1885. The report was presented, subject to the approval of such members of the committee as had not had an opportunity to sign it, and was very full and complete. Probably this code will eventually be adopted, in a somewhat altered form, as the standard code of the society.

The other sessions of the convention were devoted to the presentation and discussion of the various papers. Abstracts of such of these as are of general interest will appear in this and succeeding issues. Following are a few brief selections from the more non-technical sections of Mr. Warner's address:

MR. WARNER'S ADDRESS.

The era of large telescopes may be said to date from 1845, and the race for supremacy has been a rapid one; for during the last fifty years the power of telescopes has been increased seven-fold. The superlative degree has been applied, in turn, to the 18-inch telescope of 1861, now at the Northwestern University, and to the 26-inch, made in 1871 for the United States Naval Observatory. Next the honor was transferred to Russia, where at Pulkowa, in 1881, a 30-inch telescope was installed. This remained the largest until the 36-inch Lick telescope was completed in 1888. A general impression seemed then to prevail that the limit of size and power had then been reached, and that the observatory on Mt. Hamilton would maintain its position as the Supreme Court of Astronomy for a long time. Its supremacy, however, extended over a period of only nine short years; for the present year has witnessed the completion and dedication of the Yerkes Observatory, whose giant equatorial, now the largest, is surely destined long to remain so, unless surpassed by the monster projected for the Paris Exposition of 1900—projected, not completed, for these terms are by no means synonymous in optics.

ENGINEERING DIFFICULTIES.

Not only do the casting and figuring of a great lens demand ability of very high order, but the mounting has passed from the province of the mechanic and instrument-maker to that of the engineer. Consider for a moment this element as found in the 26-inch telescope of the United States Naval Observatory, the 36-inch Lick, and the 40-inch Yerkes telescopes, which, while possessing differences such as rendered the construction of each a matter of independent design, are yet of the same general type. The problems presented to the engineer in designing and constructing such great celestial engines are many and varied. Let us examine a few of them in the case of the Yerkes instrument. The weight of the 40 inch objective, with its cell, is

1 000 pounds. The weight of the entire telescope is 70 tons. The tube alone weighs 6 tons and is 62 feet long. Now the column supporting these heavy movable parts must be rigid in the last degree, and yet of convenient form. To secure these results it is made rectangular in shape, and is cast in four sections rigidly bolted together. The lower section has a broad, extended base 14 by 18 feet, anchored in the solidest manner to the masonry foundation. The upper section contains the driving clock and its attendant mechanism, while surmounting this section is the equatorial head, supporting all of the movable parts of the telescope. The great tube must be as free from flexure as possible, and of such form and construction as to insure minimum weight. It is made of steel in five sections, the central section being so designed as that the declination axis may be accurately and rigidly fastened to it. The weight of the tube, the axes, and their connections, all of which must move when the telescope is following the apparent motion of a star, is no less than 22 tons.

Provision must be made for conveniently pointing this monster "optic tube" to any part of the visible heavens. This is roughly and quickly done by the electric motors, one giving the motion in declination and the other in right ascension. Two smaller motors are also provided for giving slow motions in both directions. By the aid of these motors the astronomer is able to bring the star to the centre of the field, in coincidence with the micrometer wire. These movements must also be easily made by hand, either by the assistant on the balcony or by the astronomer at the eye-piece.

The driving clock which is located in the upper section, must be able to carry all this great weight in exact siderial time, so that the star shall appear to stand still as it is bisected by the spider web of the micrometer in the focus of the telescope. The propelling power is obtained by a weight of 850 pounds, which, when the clock is in motion, falls 1½ feet per minute. The mechanism is controlled by a double conical pendulum so mounted as to make one revolution per second, whether it is carrying the telescope or not. Finally, since the success of many important observations depends on the constant and regular motion of the driving clock, an electric motor must be introduced for automatically keeping it wound.

Such are some of the provisions made for the convenience of the astronomer in handling a large instrument. The mechanism is of necessity complicated, and, as has been said, belongs distinctly to the sphere of engineering.

THE USE OF THE TELESCOPE.

In the second century B.C., Hipparchus, the father of mathematical astronomy, by comparing his own observations with those recorded 147 years earlier, demonstrated that the length of the year, instead of being 365¼ days, as it had hitherto been considered, was 365 days, 5 hours, 55 minutes, 12 seconds. This is the first example in the history of astronomy where a result was deduced by a comparison of widely separated observations. His result, as determined over 2 000 years ago, is in excess of the correct length of the year by but six minutes.

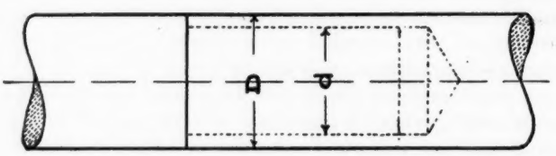
The original use of the telescope was to study the motions of heavenly bodies, but to mere observing have been added photography, photometry, spectroscopy, and so the telescope has passed through a form of evolution that allies it to the history of civilization. While astronomy, as we know, is, of all sciences, the one most removed from the sphere of commercial results, yet the telescope, in some form or another, is the one and only means we have of navigating ships, of measuring wide expanses of territory, of determining latitude and longitude, and of keeping time. Every navigator who sails out of sight of land must have a fair knowledge of astronomy. His compass tells him approximately the cardinal points, but it gives him no hint as to where on the broad ocean he is. Every ship, therefore, that crosses the ocean, goes out equipped not only with optical instruments for taking the altitude of the heavenly bodies, but with a nautical almanac containing the exact position of the sun, moon, planets and fundamental stars for each day; so by careful observation and simple computation the navigator can closely determine his latitude and longitude.

Government observations keep their corps of eminent astronomers ceaselessly at work making and reducing observations for the use of navigators, who are supplied with these nautical almanacs indicating the position of the heavenly bodies for several years ahead. The telescope is just as indispensable, too, to the surveyor. In laying out a railroad across the continent his position is found by observing his latitude and longitude. The distance from New York to San Francisco has never been closely measured but the engineer has accurately determined it by comparing his observations made at the two places. It is practically impossible to measure the distance between New York and Liverpool, but very easy to determine it within a few hundred feet by the aid of the telescope. Rivers and mountain ranges are often taken as dividing lines between countries; but where these natural lines are not diplomatically located, the telescope is brought into requisition, and imaginary lines, designated by degrees and minutes of latitude or longitude, form the divisions sought.

HOLLOW AND SOLID SHAFTS OF EQUAL STRENGTH.

WILLIAM SANGSTER.

The writer wished to couple two shafts as per accompanying sketch, the joint to be flush and the shafts to have equal torsional resistances. It occurred to him that a ratio should exist between these two shafts which could be expressed as a proportional part of either.



The usual formulæ for strength of shafting give

$W R = .196\, d^3 f$ for solid shafts..... (1)

and

$$W R = .196 \left[\frac{D^4 - d^4}{D}\right] f \text{ for hollow shafts.....} (2)$$

where

$W R$ = torsional load.

f = safe working stress.

D = outer diameter of hollow shaft.

d = inner diameter of hollow shaft, also diameter of smaller shaft.

Combining (1) and (2),

$$.196\, d^3 f = .196 \left[\frac{D^4 - d^4}{D}\right] f$$

and eliminating common factors, we have

$$d^3 = \frac{D^4 - d^4}{D}$$

When both shafts are of the same material, we have, by substituting unity for the outer and inner diameters respectively,

$D = 1.$	$d = 1.$
$d = .82$	$D = 1.22$

For a hollow shaft of brass and an inner one of steel we have, calling the working stress on the brass as one-third of that on the steel,

$$3\, d^3 = \frac{D^4 - d^4}{D}$$

or

$D = 1.$	$d = 1.$
$d = .65$	$D = 1.54$

When the hollow shaft is of cast iron and the inner one of steel, with ratios of strength as 1 to 4, we have

$$4\, d^3 = \frac{D^4 - d^4}{D}$$

or

$D = 1.$	$d = 1.$
$d = .6$	$D = 1.66$

Summarizing:

	Steel.	Brass.	Cast Iron
With diameter of outer shaft = 1, diameter of inner shaft =	.82	.65	.6
With diameter of inner shaft = 1, diameter of outer shaft =	1.22	1.54	1.66

These values in each case are taken for an inner shaft of steel and an outer shaft of the metal given at the head of the column.

SHOP TALKS WITH THE YOUNG MECHANICS.—1.

A FEW SUGGESTIONS BY WAY OF INTRODUCTION. THE HAMMER AND COLD CHISEL.

W. H. VAN DERVOORT.

In this series of talks it is hoped to present to the young mechanics some points pertaining to the tools with which they come in daily contact and about which they are often unable to obtain all the information necessary in order that they may use these tools correctly and efficiently.

Before starting our topic a few words of a general character may not be out of place.

The correct manipulation of metal working tools comes perfectly natural to many of our young mechanics, and they easily become expert in their use. It seems to be born in them, and they make good workmen no matter how poor the tools with which they work and how bad the instruction they receive; but where one such man is found there will be a dozen others who can acquire the necessary skill to be called good machinists, only after careful study and close application of the most thorough instruction. The time required to accomplish this will depend entirely on the man and the conditions under which he works. Under favorable circumstances two to six years will be required. The more the apprentice reads and thinks the more quickly will

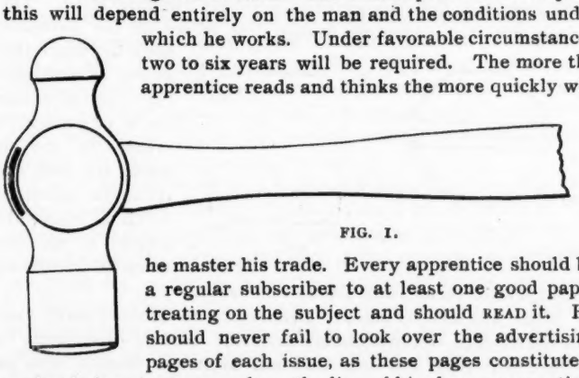


FIG. 1.

he master his trade. Every apprentice should be a regular subscriber to at least one good paper treating on the subject and should READ it. He should never fail to look over the advertising pages of each issue, as these pages constitute a perfect index of progress along the line of his chosen occupation. The reading will create thought, will broaden the ideas and put the young man in a better position to appreciate what he sees and hears.

The young machinist must keep constantly before him the two requisites of a good mechanic—accuracy and rapidity. The first he must acquire, and if he would succeed in these days of close competition, he must couple with it the ability to produce such work quickly. He should, above all things, train his judgment, having it continually with him, and should learn as quickly as possible the strength of the materials with which he is to deal. This will come more by experience than by calculation and let good judgment and common sense aid in making the experience bill low.

"Observation is a great teacher." Therefore we should learn to observe, noting carefully the ways in which the skilled mechanic performs his work. His thoughts must be kept continually on the work in hand, studying better and quicker ways to do it. He can gain the confidence of his employer in no better way than by strict attention to his work, careful observance of all regulations pertaining to the management of the plant, and a sincere disposition to do at all times his very best. He should be perfectly free to ask questions; sensible ones, as the other kind will injure his cause. He must be cautious about making suggestions as they are usually not thankfully received. When the foreman gives precise instructions as to how to perform a piece of work, the instructions must be followed to the letter, even though he thinks he can do it in a better way. He is probably wrong, but if not the opportunity to do it his way will come soon, and in such a way as to please rather than provoke, by proving the better method.

He must learn to take a hint, as the foreman may at times suggest rather than tell him that it would be best to do the other way; and above all things he must not have to be told a second time. It is bad to duplicate accidents to tools or mistakes on work, and especially so when previously cautioned on these points.

He cannot be too neat and orderly, not only with his tools and work, but in his personal appearance.

The young mechanic should never lose an opportunity to visit other shops, as he will be sure to get some good ideas from them. More can often be learned in some poorly equipped, illy-managed concern than in a shop running under the most perfect system, as we are often more forcibly impressed with the how

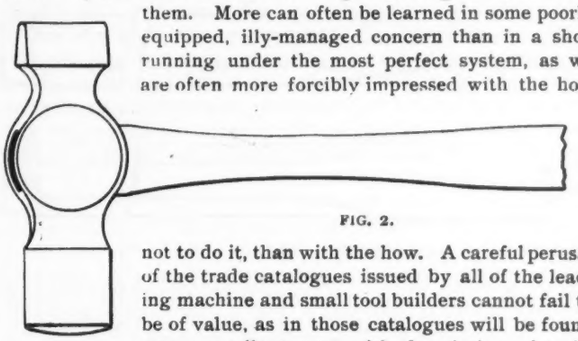


FIG. 2.

not to do it, than with the how. A careful perusal of the trade catalogues issued by all of the leading machine and small tool builders cannot fail to be of value, as in those catalogues will be found many excellent cuts, with description of tools, and often valuable hints on their manufacture and uses.

THE HAMMER.

The hammer and cold chisel are a noisy pair with which the apprentice becomes acquainted early in his shop experience, and his aching arms and battered knuckles tell of the introduction.

The machinist hammer, as generally used, weighs from three-fourths to one and one-half pounds, exclusive of handle. It is made of high-grade steel, carefully tempered on head and pene and usually of the form shown in Fig. 1. The eye is left soft as it will, in that condition, better resist the shock without danger of cracking. The head is usually made cylindrical with a slightly crowning face. For the ball pene is often substituted the straight pene, Fig. 2, and the cross pene, Fig. 3. The pene is used almost entirely for riveting purposes. The eye should be enlarged slightly at each end; the handle can then be fitted in from one side and wedged to fill the enlargement of the eye on the other side. Hard, smooth wedges are not suitable for this purpose, as they jar loose too easily. Soft wood or roughed metal wedges serve the purpose well.

The handle should be of straight-grained, dry, second-growth hickory, twelve to sixteen inches long; depending on the weight of the hammer. The handle should not be too stiff in the shank as too rigid a connection between hammer and hand causes undue shock, and consequent tiring of the hand. It should be so set in the eye that its length is at right angles to the axis of hammer head, and its long cross section parallel with this axis.

The face of the hammer should be kept true

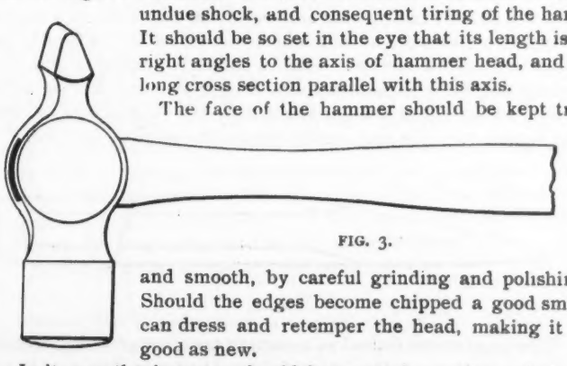


FIG. 3.

and smooth, by careful grinding and polishing. Should the edges become chipped a good smith can dress and retemper the head, making it as good as new.

In its use the hammer should be grasped near the end of the handle, giving it a free arm swing and carrying the head through a nearly vertical plane. If the plane of the swing approaches a horizontal the weight of the hammer will produce a twisting effort on the fore arm which will be very wearing. The handle should be grasped with only sufficient force to safely control the blow.

THE COLD CHISEL.

Machinists' cold chisels, for ordinary shop uses, are generally made from seven-eighths or three-fourths inch octagonal steel, and when new should be about eight inches long. The flat sur-

facing chisel, as shown in Fig. 4, should be dressed about three inches back from the cutting edge. The flats A A should be plane surfaces symmetrical with the sides of the octagon. The thickness of the bit at C should not exceed three-sixteenths inch for ordinary work and can usually be made somewhat thinner. Care must be exercised in the grinding of the facets *c c*. The angle of these faces with each other will depend on the hardness of the metal to be cut. For the softer metals, as copper, babbitt and lead, 25° to 30° will work well; for brass and cast iron, 40° to 55° and for steel, 60° to 70°. The smaller this angle the more nearly will the center line of the chisel approach the plane of the work and the greater will be the cutting resultant of the blow. It is therefore advisable to make this angle as small as the nature

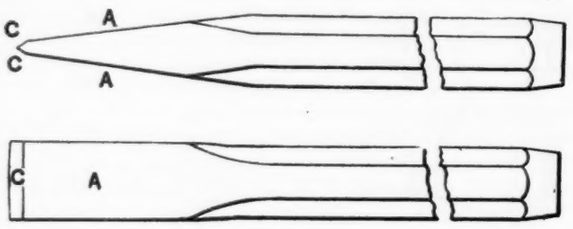


FIG. 4.

of the work will permit. These facets should be ground straight in their width, as shown at A, Fig. 5,—not rounded as shown at B, as in that case the facet would not form a guide and it would be found difficult to make a smooth, straight cut. The facets should also be ground at a uniform angle with the flats, thus bringing the cutting edge parallel with the flats, as shown in end view at A, Fig. 6, and not as shown at B. The cutting-edge formed by the intersection of these facets should be at right angles to the length of the chisel. For smooth chipping the cutting-edge should be slightly rounded in its length, as shown in Fig. 7. When ground straight the corners *e e* are likely to dig into the work and are more apt to break away than when ground rounding.

In forging, the cutting-edge should always be made wider than the diameter of the body of the chisel. When the tool is to be used on wrought iron or steel this width should exceed the diameter from one-thirty-second to one-sixteenth of an inch, Fig. 4:— but when for use on the softer metals the excess may be as much as one-half of the diameter of the body, as shown in Fig. 12.

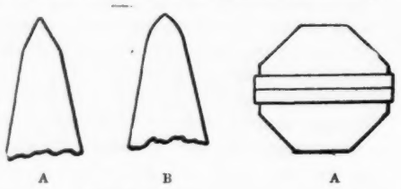


FIG. 5.

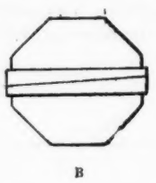


FIG. 6.

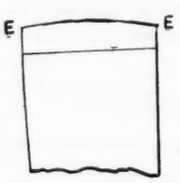


FIG. 7.

The flat chisel can be modified in form to suit special conditions, as for example, the cutting of the flat sides of a mortise requires a chisel the axis of which will follow a line nearly parallel to the work surface. Such a chisel is shown in Fig. 8, in which one flat is parallel with the length of chisel having at the end a wide facet at a slight angle with the length, this in order to be able to guide and control the cutting-edge of the tool.

FIG. 8.

The cape chisel is used as a parting tool, for grooving and key waying. It is of the general form shown in Fig. 9. In this chisel the thickness at A must be less than the length of the cutting-edge in order that the tool can be given a small amount of side-motion in the groove it cuts, otherwise it would be difficult to guide the cutting-edge. This chisel, when made as shown in Fig. 10, forms the tool usually used for grooving oil ways in loose pulleys and shaft-bearings.

The diamond-pointed chisel is shown in Fig. 11. This tool is usually used for squaring corners, and is generally made as shown in figure.

The head of all chisels should be dressed round and somewhat reduced in diameter, as shown in figures. Where the head becomes battered redress it, as small pieces of steel are apt to fly from a bushed chisel head embedding themselves deeply in the hand holding the chisel.

In using the cold chisel grasp it near the head with the full hand, knuckles up. Do not hold it too tightly but with sufficient force only to guide and hold it to the work. When the surface of the work is difficult to get at the workman is justified in holding the chisel between thumb and fingers, or with palm of hand up.

The eye should follow the cutting-edge, not the head of the chisel, when delivering the blow, and light taps with the hammer should not be used before each heavy blow. It will require

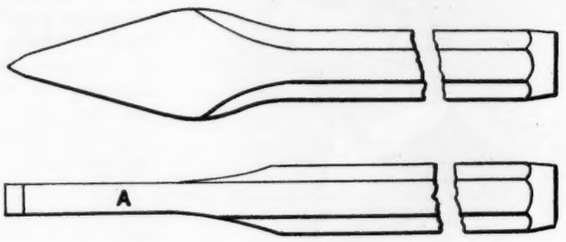


FIG. 9.

some practice before the beginner can accomplish this without disastrous results to his knuckles.

In tempering the chisel for general machine shop work it should be drawn nearly to a blue which gives a hard temper that will stand well on all, except chilled iron and hard steel work.

A LOOK AHEAD.

Scientists tell us that while the bituminous coal supply of the earth is practically inexhaustible, some of our great grandchildren will find the anthracite supply running short. They claim that it is definitely known just where all the anthracite beds lie, what their extent is, and making due allowance for a regular increase in the demand for coal, that it can be calculated with a reasonable degree of accuracy when all of this deposit will be turned into smoke and ashes.

What will take its place? Ericsson, who devoted many years to the subject, would probably say some method of utilizing the direct heat from the sun, and our electrical friends, who are enthusiasts over the development at Niagara, would answer, Water power with electrical transmission. People in the coal districts think that the enormous culm heaps will yet serve a good purpose, and the long line of inventors of smoke consuming devices believe that when their ideals are realized bituminous coal will be good enough for anybody. Greater than all the "unharnessed forces of nature" are the tides which were taken

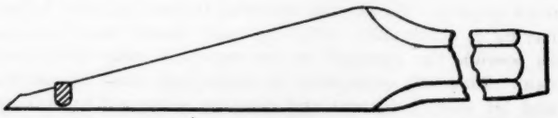


FIG. 10.

advantage of by old New Englanders, who ran "tide mills," and which may be taken advantage of again.

While it is interesting to scheme on these great inventions of the future, it ought to be impressed upon every would-be inventor of the present that they *are* inventions of the future. The problem is not ready to be solved yet, and it won't be in this generation, although a good many inventors seem to think otherwise. It is a good problem to let alone. When the final result is reached it will come through a gradual growth or evolution. Thousands and perhaps millions will work on it, and about one in 10 000 will make something, while the other 9 999 will lose. At least, that is my opinion.

ED. ISON.

NOTES FROM NOTOWN—20.

ICHABOD PODUNK.

ENLARGING TOO RAPIDLY—CUTTING WAGES AND ITS RELATION TO SHOP EXPENSE—BRAINS *vs.* FATE—HEATING THE SHOP.

There are some new men in the Notown Manufacturing Company, for it has become a stock company and things are going to hum, so they say. They wanted Mr. Brown, the Superintendent, to take some stock, but he declined with thanks, and has told me privately that he didn't propose to put money into a concern run by men that he didn't know whether they knew enough to run a sausage factory or not. Said 'twas bad enough to have to risk his job without all his spare cash as well. Brown has a

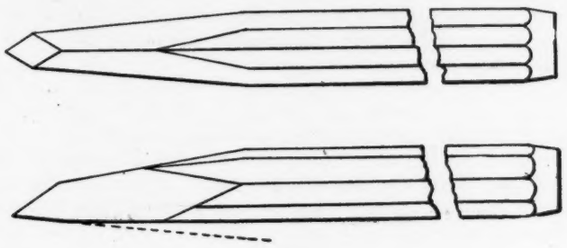


FIG. 11.

level head. If Podunk ever gets 17 cents together he can call his own he don't put it into a concern he doesn't know or doesn't manage. For while its mighty handy to lay the loss of it to somebody else, you always have a sneaking suspicion that if you had managed things they wouldn't have busted.

Well, the first thing they went into was bicycles, and because they fooled an agent into ordering 500 wheels, they started to build an addition to the factory. The Notown *News* reporter wasted three columns of good paper in telling of the enterprise displayed, of their large capacity after the change and made a rather disrespectful comparison between the new management and the old. But the changes went on, the last dividends went into new tools, and if they don't have a blue elephant on their hands in a year I miss my guess. I'd rather have a small shop filled with work than a big factory with a lot of tools looking hungry for want of something to do.

This enlarging fever is an expensive as well as an expansive disease and many a concern goes to the wall, or under it, from spreading faster than they can get steady work, to fill the increased capacity. A crowded shop is bad enough, an empty one is a great deal worse, both for the stockholder and the workman.

There is a similar case I know of, only it's large machines instead of bicycles, where this kind of folly is fast eating into the principal of its large capital stock, instead of earning big dividends as it formerly did.

Not satisfied with being the largest shop of its kind in the country, they wanted more of a distinction and about doubled

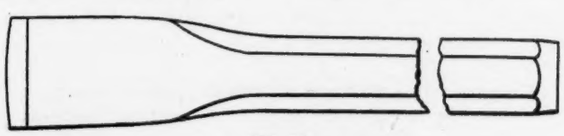


FIG. 12.

their capacity, but since the depression began have been using but a small portion of their plant, the rest being a constant expense without any income from it. The Notown Manufacturing Company are on the same road, sure.

THERE's quite a difference in handling men. You've probably heard that before, Mr. Editor, but it's true, just the same. I have in mind a case which shows this distinction as plainly as any I know of. A little shop near here does a variety of work, has a variety of men, and like most shops, tries to make money.

Their former manager was a hustler of the common kind, which means that he made a great bluff at getting out work, swore big swears when a job took longer than he thought it ought to, and made himself generally disagreeable to the men, which of course made them work hard for his success—I don't think. He was one of the kind of men whose only idea of cheapening work was to cut wages, and who would think that a man who would work for nothing could chip gear teeth cheaper than a $3.00 a day man could on a Gould & Eberhardt duplex gear cutter. These are the men who never buy new tools, but expect men to cheerfully accept a reduction of wages in order to enable the company to compete with its rivals. When the men object to lower wages they are called ungrateful to the employers who have so long provided work, etc., etc., and other similar rot.

There's another side to this, it seems to me. If there's any debt of gratitude due, its about evenly divided, for if the men get employment, the employer gets the profit on their labor, so it's about an even toss up all around. When you hear about an employer doing so much for his employees, it's time to inquire what his employees have done for him.

Well, this alleged manager finally dropped out of the race and another man, a shop man too, was selected for the place.

This man knew his business, knew that wages in a machine shop played a far smaller part than where a man was chopping wood for a living. The main factors of cost in the shop, are in many cases, the tools and appliances for the men to work with. The best man on earth can't make money for a firm by trying to compete with a screw machine or a hand lathe with a chaser and hand tool.

The new man knew this and knew that cutting wages was poor policy and didn't help matters in the end. He devised ways of doing work, of reducing time lost between jobs, made the foreman have a job waiting for the men, instead of having the men chase him all over the shop, trying hard not to find him, to know what to do next. When he had a rush job come in he told the men the circumstances, told them he wanted it in a hurry and that he would appreciate fast work. Appreciate it so much in fact, that he wouldn't think of cutting their piece rate if they happened to make "big money." And he didn't either.

The office kicked when they found men drawing $4.00 a day pay. That would never do. But the new man was firm and wouldn't hear to a cut. "Now see here" he said to the treasurer, "you told me to get that work out on time, to hire more men, if necessary, but get it out, as it meant dollars to the company. So I told the men to go ahead, get the work out as fast as possible and I'd see that their rate wasn't cut. Now, because they make a dollar a day extra for three days, you kick, when, to have hired extra men would have cost double and not got it out so fast either.

"You don't seem to realize that they practically increased the capacity of your plant 25 per cent. without costing you a cent for tools, building or taxes, simply the labor. I promised them there would be no cut. If there is, then you can get a new man tomorrow and I'll try and find a place that has a treasurer who can see past a dollar; you seem to let it blot out of your view all the other dollars that lie beyond it," and he turned to go.

"Hold on, Jimson," said the treasurer, "it isn't the money so much as the precedence. If a man can make $4 a day once he'll want to again."

"Well, hang the precedence that wouldn't let him if he did work enough to earn it as he has this time. I'd feel nice and honorable, wouldn't I, after asking the men to help me out and getting them to work as hard as they could, to cut their rate so they couldn't make but $3.00 a day if they worked at high pressure all the time. No, sir, Jimson isn't that kind of a man. If I can't show you more net profit at the end of a year than you've ever had, I'll resign, but you must let me run the wages business as well as the other, or I'll quit now. The best way to make money is to have good tools and hire men who can earn good wages—the wages are not the only consideration."

Jimson is a man of ideas, good ones too.

ONE of Mr. B.'s old shopmates wandered in the other day and had a great tale of woe, because he hadn't had any show in the world, and was still a machinist.

"Now there's Bill Bunker, who worked with us both and who couldn't do any better work than either of us, and see where he is; general manager of the Colossal Monkey Wrench factory and getting—well, I don't know how much he is getting, but it must be a whopping big salary. I'm getting to be a fatalist Mr. B., and it does seem as though fate was against me. I've worked hard, but haven't been able to get ahead any, and haven't got $500 to my name."

After he had gone Mr. B. told me the why of it all, said he guessed fate had less to do with it than lack of horse sense.

"I'll tell you, Podunk, it's like this. Bill Bunker was a good workman. Possibly not a bit better than our fatalist friend, but he mixed more horse sense with it. Horse sense is a pretty good thing to mix with any work, and to my way of thinking, it's what makes the difference between failure and success.

"Bunker was a man who tackled anything that came along, whether he liked it or not, and didn't kick every time he had a chance. Any one who wants to kick can usually find a chance.

"Things didn't always go smoothly with Bunker either; he had a good deal to look after, both in the shop and out and had trouble of his own too. Mr. Fatalist was always growling, things didn't go right. If the stock happened to be hard, he kicked, and when a new concern offered him a job, he took it without stopping to think whether the new shop would exist six months or not. It didn't, and he was back again and at the foot of the ladder, while Bunker stuck at it and soon got to be foreman.

"Here his horse sense came into play and he got out the work in a way that pleased all hands, even the kicker. Well, to make a short story long, he kept working, using his head all the while and got to be well known as a manager of men and shops. That's how he got to be manager and get his big salary. He gets it because he earns it and because he can manage things to advantage.

"The successful shop man is the one who can plan work to advantage, who can handle men so as to get out the work without being constantly nagging his men and antagonizing them.

"In all probability Bunker had more or better brains to start with, but the fate part is either lack of endowment with brains or something similar. It may be tough on the fellow who lacks the brains, but they win every time."

I don't know whether to entirely agree with Mr. B. or not. I know brains count a good many per cent. toward the successful average, but I think that opportunity is also to be considered.

I don't doubt the case Mr. B. told of was all true, but I believe there are cases where the brains don't get the opportunity. Opportunities can sometimes be made, but not always, and it isn't quite a square deal to lay it all to lack of brains. I feel a little strongly on this subject, probably because I'd rather be a manager than a lathe hand in a Notown shop.

I WENT visiting the other day and went into a shop where the heating system wasn't according to Hoyle, at least didn't keep the shop warm. It was about 10 o'clock when I arrived and the frost was just getting off the windows at the main end.

The men were just beginning to move fairly lively and I thought something must be wrong with the place. "Kinder cold morning outside," I said to break the ice. "Yes, and inside too. Any shop that won't heat up before noon, ought not to expect much work on a cold day," replied the foreman.

I asked for information and the foreman let out a little; seemed to need sort of a safety valve to prevent busting, and he blew off on me. Can't say as I blame him much either. He said:

"I came in early this morning as I always do, and what do you think that thermometer there said? Couldn't guess, eh? well I knew you couldn't. Said twenty-eight degrees above zero, four degrees below freezing at seven minutes to seven o'clock. Think of that for a shop in a civilized town with the years only lacking three of the twentieth century. It wasn't nothing new either, seen it there before, and expect to again, as long as they have that heating system they have now. Whose is it? I don't know, and it's just as well I don't, or there might be war if I ever met anyone connected with the company. They coax air over a lot of pipes that the exhaust steam crawls through and squirt it into the shop down at the other corner. I believe they are supposed to use live steam in the morning before the engine starts up, but if they do we never know it. About 8 o'clock the upper end of the shop gets warmed up and then some jay goes and shuts the flopper to keep the hot air out because he's too warm, while us poor devils in this end of the room are wearing icicles on our whiskers.

"We don't blame them for not wanting to roast any more than we want to freeze, but we do blame the company for not using some means to heat the shop decently. It may be all right to heat shops by injecting a little hot air in one end and letting it wander along through 250 feet of shop, but I notice the office put in steam heat instead of depending on hot air remnants.

"They may think any old thing is good enough for the men, but aside from the slight inconveniences of cold feet, pneumonia and the like, the company gets the worst of it every time. No man can work in such a cold shop and they wouldn't if they could. Do you 'spose I'm going to hustle a man when he can't take hold of his lathe without leaving a chunk of skin on it, unless he wears mittens, and 'specially when my own teeth chatter so I have to keep my mouth shut to prevent loosing my own false ones?

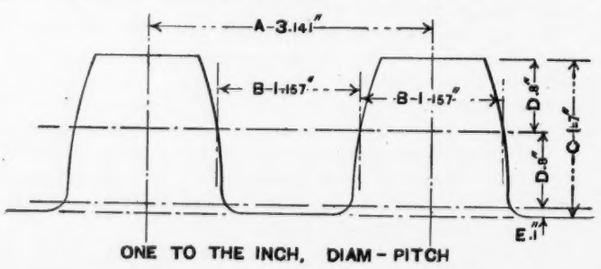
"No, siree. I figure they loose a good hour's time on each man in my department every cold morning, and when they are pushed on work, this means quite a little sum of money in the course of a winter, enough to make some decent arrangement for heating the shop. They've let this go three winters now, and I think by next year me and my men will be in good training for a Peary arctic expedition or a trip to the Klondyke to dig gold. There, the last man has his overcoat off now and we'll have to hustle now to make any kind of a showing for the day. Glad to see you any time, but don't come before noon, unless you have your life insured, or wear a fur coat."

I've seen some pretty tough things in my different shop experience, but if anybody had told me that a shop in an enterprising town of nearly 90,000 inhabitants would be found in such a condition at this late date, I'd have been skeptical and wanted to see it myself. But I've seen this, Mr. Editor, so there isn't any ghost story about it. Isn't it about as fine an example of how not to manage a shop as you ever saw? This is one of the most expensive economies I know of, and it is to be hoped, for the sake of the men who work there (for want of a better place) that this will be remedied before another winter.

BEVEL GEAR FORMULA.

F. W. CLOUGH.

I send you a new (perhaps to many readers of this paper) formula for the proportions of the teeth or bevel or mitre gears which materially lessens the difficulties occurring in the use of the ordinary diametrical pitch system. This new depth formula makes the task of cutting bevel wheels on the ordinary gear-cutting machine, by the use of a fixed curve cutter, cutting around the wheel twice as is usually done (outside of planing the teeth, or cutting by any special process) an easier one to produce first-class running teeth, and at the same time producing a tooth and wheels which are strong and better than



the ordinary depth system. The diagram shows the relative proportion in one to the inch diametrical pitch; of pitch; thickness of tooth and space on pitch line; and clearance in bottom of space.

A = pitch; B = thickness of tooth and space at pitch line; C = the entire depth of space cut; D. D, = working depth of tooth; E = clearance of tooth.

If we wish to get out the size for smaller teeth we simply divide A, B, C, D, and E by the pitch desired; as for example, a 5 to the inch is desired we have simply this in figures:

A ÷ 5 = .628" = pitch.
B ÷ 5 = .314" = thickness.
C ÷ 5 = .340" = depth.
D ÷ 5 = .160½" = working depth.
E ÷ 5 = .020" = clearance.

Also in connection with this new formula for depth of tooth we use a form of tooth and cutting angle, in cutting a tooth, which so closely approximates the planed tooth in running that it is difficult to distinguish which from the other, so far as smooth running is concerned; more again.

* * *

IT is said that all the coal mined daily in the world would be about sufficient to pump back the water that runs over Niagara every 24 hours.

PRACTICAL PATTERN MAKING.—8.

PATTERNS OF DECK LUG AND WATER COLLAR FOR DRY SAND MOULDING.

I. McKim Chase.

In constructing large patterns to be moulded in dry sand it is frequently advantageous to arrange them for moulding somewhat after the manner of constructing loam moulds; that is, to permit of the mould being made in sections which can be lifted away from the seat or foundation of the mould. The main core can then be made and finished on the seat and be allowed to remain there. The sides of the mould, which are sometimes called cheeks, are assembled around the core. This plan obviates handling the core, which may be large or of such a shape as to make the safe handling of it very difficult.

XIV

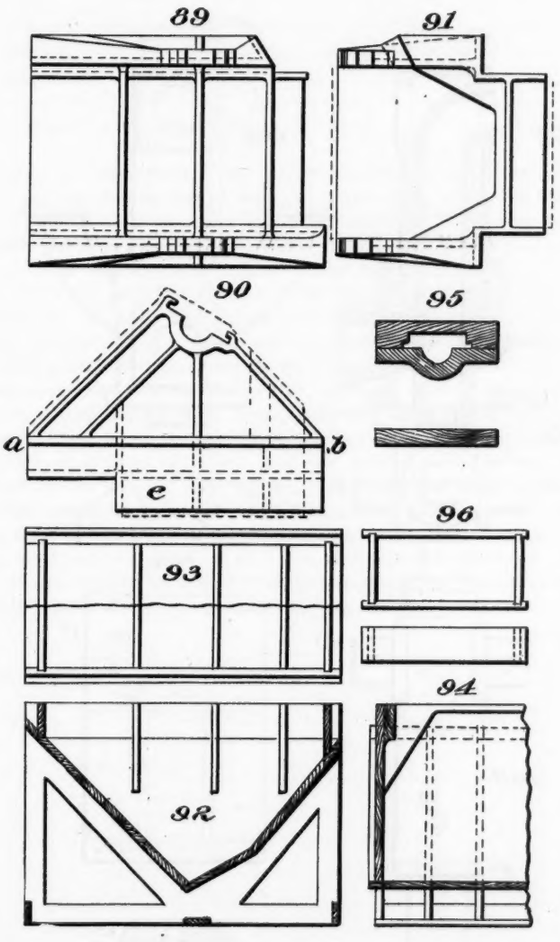


Illustration XIV. represents such an object, which is a deck lug for a gun mount. Three views of the casting are given—a plan (89), a side (90), and an end elevation (91).

The pattern is moulded with the bearing downward. The ribs, flanges and other parts projecting from the sides are arranged to be removed with the cheeks. View 90 also answers for the side view of the pattern when completed. The dotted lines outside the inclined ends represent the core prints for the main core. The pattern separates or parts on the line *a*, *b*.

In constructing the pattern a number of frames made of 2-inch lumber are first provided. These frames should be about 1¾ inches less all round than the section of the pattern where the frames are located. The frames are set up and properly arranged according to the position they are to occupy in the pattern; they are then covered with boards a little in excess of 1¾ inches thick; these are secured to the frames with screws and glue, the holes for the screw-heads being counterbored and plugged after the screws are in.

When the box so formed is dressed down to the proper dimensions it forms the body of the pattern upon which the outside ribs, bosses, flanges and other projecting parts are secured. This is done with draw-pins, screws being also used to insure the parts against shifting until the pattern is set up for moulding. The draw-pins are removed as the mould is being built up.

Shallow core-prints are fitted to the two inclined sides of the pattern for the purpose of locating the core box when placed upon the seat of the mould. The upper or cope part of the pattern, *e*, is constructed in a similar manner to that described in the foregoing.

Three views are given of the main core box, 92 being a longitudinal section. The plan, 93, not being correct to scale in width, is shown broken through the middle. Fig. 94 represents a half cross-section of the box.

The main core box is constructed by first preparing a bottom board, which is secured to frames having the angle of the pattern where the core prints are located. The sides and ends of the core box are erected upon the bottom, and are screwed together so that they can either be taken apart or removed from the bottom without being taken apart.

The bottom board of the main core box is not essential, absolutely, when the core is made in the place it is to occupy in the mould, as here intended. But by having it the box is better retained in shape and, if so desired, the core can be made and set in the mould afterwards, as commonly done.

Fig. 95 shows the box for the trunnion bearing cores, and 96 the box in which the cores are made for the cope part of the pattern. These are plain boxes and require no further description.

In moulding the pattern there is first prepared a seat or foundation corresponding in shape to the part of the pattern where the core prints are located, and the pattern is placed upon this seat. The sides or cheeks of the mould are then built up and arranged to be lifted away from the mould without affecting the seat. The ribs, flanges, etc., on the sides of the pattern are lifted away with the cheeks, the pins and screws which secured them to the sides of the pattern having been withdrawn when the cheeks were being built up. The cope, or cover, of the mould is also completed before the mould is dissembled.

After the cheeks are removed the main core box is lifted from its bottom and placed upon the seat of the mould, according to the position marked by the core prints; the core is then completed and allowed to remain on the seat. When the mould is being assembled the rectangular cores are supported on chaplets placed upon the main core.

PATTERN WORK FOR WATER COLLAR.

Illustration XV. represents a water collar and the pattern work for it.

Water collars are used in connection with the gun turrets of war ships, and consist of two principal parts; one of these is fixed and the other revolves with the turret. Water, under pressure, passes into the collar through a branch in the outer member, thence to a central passage in the inner member, and through it to the motors in the turret. The exhaust water returns by another pipe, through an annular passage in the inner member, and thence through an outlet branch in the outer member. These castings are quite intricate; their patterns are interesting examples of pattern work, and considerable skill is required in their construction.

Fig. 97 shows a side elevation, and Fig. 98 a section of the device when assembled. The glands used for making the collar water-tight are omitted in the figures.

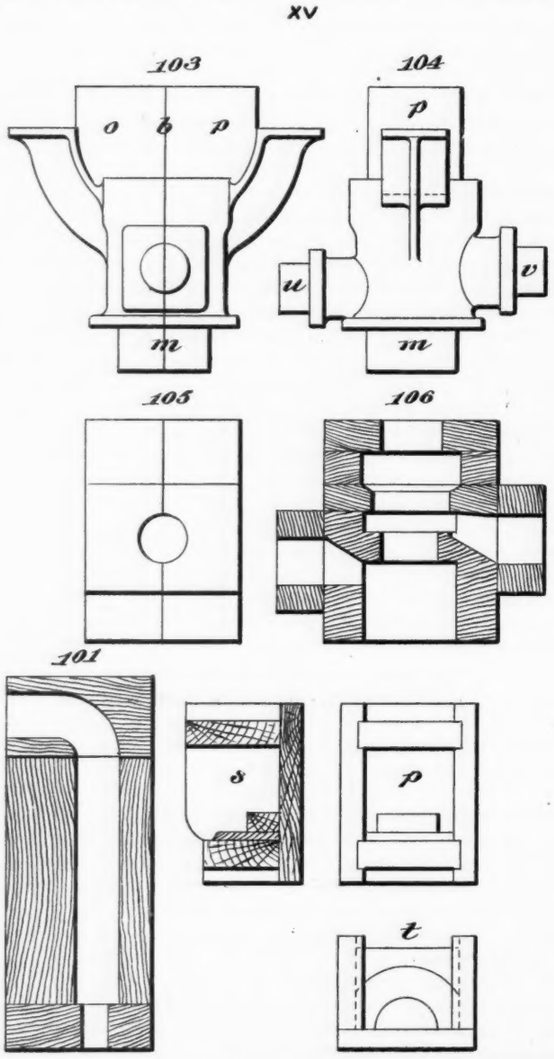
Fig. 99 shows a plan, and Fig. 100 a side elevation of the pattern for the inner member; it is made in halves, the pattern parting on the line *a*, *b*. The core prints *c*, *d*, form bearings to support the central core, and the prints *e*, *f*, bearings for supporting the annular core. Fig. 101 shows one-half the box in which the central core is made. The annular core is made in halves. Fig. 102 shows a plan and section of the box in which the half cores are made. These cores cut through the outside of the casting at *g*, *h*, where prints are located on the pattern to assist in supporting them in the mould as well as to aid the venting. The holes so made are plugged in finishing the casting.

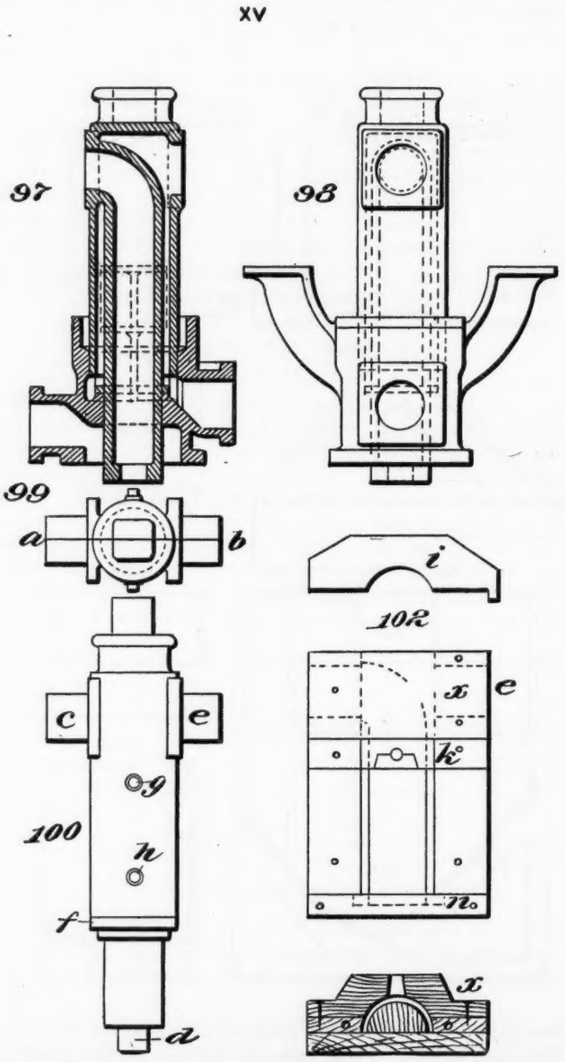
In making the box for the annular core a bottom board of sufficient size, and which should be battened to prevent warping, is first prepared. Upon this board is fitted the body *y*, representing the outside of the metal inclosing the central passage. Two pieces, one right and one left-hand, shown by dotted lines, are made for the upper end of this part where the bend is located. By interchanging these pieces both halves of the core can be

made from the same box. To form the outside of the core, two pieces, *x*, one right and one left-hand, are worked out on the inside to the outside form of the core over the bend; an opening, *e*, is cut through one side of the pieces to form the outlet opening in the side of the casting, where the core print, *e*, is located By interchanging these pieces to correspond with the bend the opening is made to match when the halves of the core are set in the mould. Fitted to the opposite end of the box is a piece, *n*, worked out to form that part of the core which lays in the impression made by the print, *f*. The strike, *i*, is for the purpose of shaping the part of the core between the two end pieces.

After this part of the core is struck off, the piece *k*, which has dowel pins to fit holes provided to locate its position on the board, is placed over the core and the small branches *g* and *h* are added to the main part by extending the core through the box. After being worked out the several pieces are assembled and secured together.

The core is supported in the mould by the bearings made by the core prints *u*, *v* and *w*, and by the bearing in the cores between the brackets.





hole in piece *k*. The square hole or socket in the upper end of the casting is formed by an ordinary square core.

Fig. 103 shows a side elevation, and Fig. 104 an end elevation of the pattern for the outer member, which has two supporting brackets attached. The pattern is in halves, and is made to part on the line *l*, *m*. The spandrel between the brackets is formed by two similar cores, one of which is secured in the drag, and the other in the cope part of the mould. The core prints, *o*, *p*, form the bearings for supporting these cores, which contain a bearing for the upper end of the interior core. When the mould is closed, the cores meet at the joint of the mould. One elevation, *r*, and two sections, *s* and *t*, of the box in which these cores are made, are also shown.

Fig. 105 shows an end elevation of the box in which the interior core is made.

Fig. 106 shows one-half the box viewed from the interior. The box is built up of several pieces, as the illustration indicates; this acilitates working out the different diameters contained in the

AN ACCURATE COST KEEPING SYSTEM.*

H. M. Norris.

Of all the troublesome and knotty problems connected with economical shop management there are few quite so puzzling to the engineer as that of accurate cost keeping. Hundreds of systems have been invented and put into practice, some of which possess a number of points of merit; but the ideal system, such as is sought by all our large concerns, remains yet to be discovered. One manufacturer figures fifty cents per hour on all classes of work, irrespective of the machine or class of labor employed; another charges thirty-five cents per hour for boys' time and forty-five cents per hour for men's time; others add a fixed percentage to the sum of the cost of labor and material—the percentage in ninety-nine cases out of a hundred being based upon the amount Smith & Jones use, or, what is almost as bad, upon the expenses of some one preceding year—all of which is bad practice, and denotes inefficient shop management.

A cost-keeping system to be of real value must forever eliminate all guess work, and be so designed that it will give accurate results under all conditions of business. To determine the cost of any article of manufacture, it is necessary to *know* three things: the actual cost of labor, the actual cost of material, and the actual cost of running expenses. The first two items are easily found, but how to get the third, at the minimum cost, is

*Read at the New York Meeting of the American Society of Mechanical Engineers.

the problem. and one not easily answered; although the writer feels that the system about to be described is a step in the right direction.

Upon the receipt of an order at the main office, it is given a number and entered in the order book in the usual manner, after which duplicate orders are issued to the several foremen. As the work is taken in hand, the workmen in each department charge their time upon a different colored time card, the one for use in the machine shop being printed in the form shown in Fig. 1. At the close of the day these slips are collected and

FIG. 1.

TIME CARD.

Symbol *6 A 2* No. pcs. *6.* Shop No.. *1788*
Name *Jacob Kerr* No. *142* Date *8—12—'97.*

Turning 4.....	Boring.....	Milling .....
Planing.....	Chucking.....	Scraping.....
Shaping	Cutting off.....	Assembling.....
Drilling.....	Grind and Pol.....	Painting.....

Commenced *8* Finished *12.* Hrs. *4.* Amt..

handed to the foreman, who, after assuring himself that the charges are correct, turns them over to the office, where the time clerk assorts them in reference to the workmen's numbers and enters the total time made by each on that date in the pay-roll book, after which he fills in the "amounts" either calculated by the slide-rule or taken from a table which is easily to be computed once for all. The tickets are then assorted with regard to shop number; and the total number of hours worked that day in each department—the latter being denoted by the color of the card—together with the actual cost of wages paid or due on the same, and of the material used, as figured from the stock slip, Fig. 2, are entered in the daily labor and stock account book, a portion of a page of which is shown in Fig. 3. This book is ruled for the several days of the week, each line showing the actual cost of its order number for that day, and is footed up at the close of the week, thus making it an easy matter to get at the total cost of any job, at all times, with a minimum amount of labor—the hourly burden or average ratio existing between productive labor and general expense being known.

FIG. 2.

STOCK SLIP. Date *8—24—'97.*

ORDER.	MATERIAL.	@	AMOUNT.	
1788	*24 lbs. Machy Steel*	*3½*		*84*
"	*158 " Cast Iron*	*2*	*3*	*16*
1789	*200 " " "*	"	*4*	*00*

The term "general expense" is meant to include every outlay of whatever nature which is not chargeable to some specific order number, and comprises eighteen distinct charges as shown in Fig. 4.

B, all pattern work on the regular line of standard tools, or other work not chargeable to a specific number.

C, all printed matter, office fixtures, stationery, drawing paper, and other supplies used in either office.

D, all oils, waste, emery cloth, paint, nails, lumber, or other supplies used throughout the shop.

E, all productive labor upon work which is salable.

F, all productive labor, all material, and all bills for merchandise which form a part of the cost of such new tools as files, drills, monkey wrenches, oil cans, reamers, mandrils, milling cutters, etc., which may be classed as perishable.

G, all productive labor, materials, and bills pertaining to new non-perishable tools, such as machinery, jigs and fixtures.

H, all productive labor, materials, and bills chargeable to the maintenance of perishable or non-perishable tools.

FIG.

DAILY LABOR AND STOCK ACCOUNT.

Month of August, 1897.

ORDER NUMBER.	DATE.	DRAWING-ROOM.		PATTERN SHOP.		FOUNDRY.		MACHINE SHOP.		TOTAL.	STOCK.	REMARKS.
		Hrs.	Am't.	Hrs.	Am't.	Hrs.	Am't.	Hrs.	Am't.	Am't.	Am't.	
1788 26–33	23											
	24	.....	.....	.....	.....	.....	.....	5	$0.45	.....	$4.00	
	25	.....	.....	.....	.....	.....	.....	10	1 60			
	26	.....	.....	.....	.....	.....	.....	12	3 00			
	27	.....	.....	.....	.....	.....	.....	10	1 20			
	28	.....	.....	.....	.....	.....	.....	23	5 75			
Totals..	..	.....	.....	.....	.....	.....	.....	60	$12 00	.....	$4.00	
1789 26–34	23	.....	.....	.....	.....	.....	.....	50	$9 00			
	24	.....	.....	10	$2.50	.....	.....	60	10 80			
	25	.....	.....	.....	.....	.....	.....	60	10 80	.....	$5.50	
	26	9	$3.60	.....	.....	.....	$7.50	40	7 20			
	27	9	3.60	.....	.....	.....	.....	42	7 56			
	28	.....	.....	.....	.....	.....	.....	60	11 94			
Totals..	..	18	$7.20	.....	$2.50	.....	$7.50	312	$57 30	.....	$5.50	

R, all other items of expense not included in the letters from *I* to *Q*, such as wages of the foreman, time clerk, stenographer and laborers; the erection of countershafts and cranes, the moving of old machinery, the building of foundations, and the setting up of new machinery.

S, all labor spent in replacing work which is condemned through bad workmanship or other causes.

With the exception of item *E*, which, of course, forms no part of the general expense, all labor chargeable to any of the above letters is described upon blue cards, printed as shown in Fig. 5, which are turned into the office daily with the regular slips, and the cost of the same entered in the labor and stock account book, opposite their respective letters, in the same manner as the regular cards are charged to their respective order numbers.

At the end of the month, the four or five, as the case may be, of total weekly charges against each letter are added together,

FIG. 4.

DISTRIBUTION OF CHARGES FOR MONTH OF AUGUST.

A.....	Drawing Office.....	$40 00
B.....	Pattern Work	32 00
C.....	Office Supplies.....	25 00
D.....	Shop Supplies.....	286 00
E.....	Labor.....	2,340 00
F.....	Perishable Tools.....	175 00
G.....	Non-perishable Tools.....	30 00
H.....	Maintenance of Tools.....	25 00
I.....	Advertising.....	100 00
J.....	Light and Heat	.....
K.....	Traveling Expenses.....	80 00
L.....	Official Salaries.....	700 00
M.....	Rent and Power	250 00
N.....	Taxes	6 00
O.....	Insurance.....	12 00
P.....	Interest.....	75 00
Q.....	Patents and Royalties.....	.....
R.....	General Expense.....	500 00
S.....	Extras	4 60
T.....	Total.....	$4,680 00

and the sum placed opposite the corresponding letters on the distribution of charges blank, Fig. 4; analyzing which we see that of the $4,680 paid out during the month, only $2,340 went into work for which there is any compensation. Further, that the returns from this work must be sufficient to cover the $2 340 paid in wages, plus the sum of all the other outlays, amounting to $2 340 more $= E +$ 100 per cent. of *E*. In other words, we must receive $2 for every dollar charged to productive labor before we so much as pay bare expenses. The question therefore is: How can we best determine the cost of the individual job so that the total receipts for the month's work will be double the cost of productive labor? Figuring on the basis of *E* plus a certain per cent. of *E* will not do, as it makes the charge for boys' time absurdly low, and good men's time far too high. Referring to our books, we see that the labor charge of $2 340 represents 11 700 hours' work. Dividing this time into the general expense items, $2 345, gives twenty cents as the cost per hour of running expenses. Multiplying the 11 700 hours by .20, and adding the actual cost of labor, $2 340, gives $4 680, or the same result obtained by increasing the $2 340 by 100 per cent., and at the same time eliminates the objections advanced against the latter plan.

as illustrated in the following example, in which both methods are compared with the old "so-much-per-hour" plan:

3 hours at .10 =	$.30
6 " " .15 =	.90
9 " " .20 =	1.80
12 " " .25 =	3.00
30 hours	$6.00
General expense,	6.00
Actual cost,	$12.00

Col. 1	Col. 2.	Col. 3.
3 × .40 = $1.20	.30 ÷ 100% = $ .60	3 × .20 + .30 = $ .90
6 × .40 = 2.40	.90 ÷ 100% = 1.80	6 × .20 + .90 = 2.10
9 × .40 = 3.60	1.80 ÷ 100% = 3.60	9 × .20 + 1.80 = 3.60
12 × .40 = 4.80	3.00 ÷ 100% = 6.00	12 × .20 + 3.00 = 5.40
$12.00	$12.00	$12.00

Suppose the total charge against a certain job amounted to $6, consuming thirty hours' time as above, and that the cost of running expenses for that length of time is $6 more, then $12 is the amount which we must receive for the work, exclusive of all profit. Figuring, first, on the old basis of a fixed charge per hour, Col. 1, we have $12 ÷ 30 = 40 cents as the rate per hour at which each item must be charged to net $12 on the job as a whole. Figuring, next, on the basis of "wages plus a certain percentage of wages," Col. 2, we have $6 ÷ $6 = 100 per cent. as the percentage by which each item of wages must be increased to meet general expense and net the $12 necessary to cover costs. Figuring, lastly, on "time multiplied by general expense per hour plus wages," Col. 3, we have $6 ÷ 30 = 20 cents as the amount per hour which must be added to each item of wages to make the $12. Comparing the last two methods, the first being unworthy of this name, we note that while the second system of figuring accomplishes its mission so far as the ultimate results are concerned, it is manifestly inferior to the third plan, in which expenses are made on every hour of labor, irrespective of the rate per hour of the workman—the loss incurred on cheap labor by the second plan not having to be made good by overcharging for the work of those requiring greater skill.

Having thus assured ourselves of the practicability and superiority of the last described method of determining costs from

FIG. 5.
TIME CARD.

No. *176* Charge *R*
Name *John Smith* Date *8—7—'97.*

Time was put in on *Erecting counter-shaft for new style 25" Upright Drill.*

.....

.....

Commenced *7.* Finished *9 30.* Hrs. *2½.* Amt. . . . . .

hours worked and wages paid, and that the general expense for the month is equivalent to a fixed charge of 20 cents per hour of productive labor, we are now prepared to calculate the cost of each individual job, the form of blank for which is illustrated in Fig. 6. The first column is filled in directly from the daily labor and stock account book, and comprises a compete list of all the orders worked on during the month. The column headed "Balance" represents the total cost of each order up to and including the last day of the preceding month, the items being copied from the column headed "Total" on that report. Turning to our account book, we find we have 1 246 hours, costing $210.50, together with $6.25 worth of stock, charged to order No. 1 785 last month. We enter the $210.50 under "Labor," the $6 25 under "Stock," and multiply the 1 246 hours by .20 = $249.20, or the cost of running expenses chargeable to this order. Adding these four items together we have $780 as the total cost of order No. 1 785 up to the beginning of the present month. If the work is finished, this amount is then carried to the next column, and the number dropped from the following month's report. On short jobs commenced and finished in the same month, all necessary figuring may be done in a few moments on the form shown in Fig. 7, in which the cost of each department is shown separately.

Judging by the length of the description it may seem to some that this system is altogether too cumbersome to warrant its adoption in a large number of shops; but the fact of the matter

FIG. 6.
ANALYSIS OF COST OF PRODUCTION.
Month of August, 1897.

Order No.	Balance.	Labor.	Stock.	General Account.	Total.	Finished.	Remarks.
1785	$314 05	$210 50	$6 25	$249 20	$780 00		
1786	117 50	126 25	10 10	130 00	383 85		
1787	225 00	600 00	325 00	625 00	1,775 00		
1788	.....	12 00	4 00	12 00	28 00	$28 00	
1789	.....	67 90	13 00	68 00	148 00		
1790	.....	113 00	30 00	115 00	258 00	258 00	

is, that the daily book-keeping consumes not more than two hours' time per hundred men employed, and the extra labor at the end of the month is only a matter of a day, or a day and a half, at most, of one clerk's time.

At this writing the system has been in actual operation only a few months, but its advantages over all other systems of which the writer has any knowledge—and he has studied the question pretty thoroughly—has been so clearly demonstrated within that time that he feels no hesitancy in giving the plan his unqualified recommendation, barring a few minor changes in printed matter, such as inserting an extra line between each weekly division in the labor and stock account book, Fig. 3, for the carrying over of the total cost of the work to that week, etc.

In conclusion, it might be well to add, in anticipation of the possible criticism, that the system only furnishes data on a job as a whole, and not on the cost of the individual piece; that after the time is transferred from the cards to the account book, as described, the cards are filed away in pigeon holes bearing the same number as the order; and upon completion of the same the tickets are again gone over and assorted with regard to the

FIG. 7.
COST STATEMENT.

Shop No...... *For*..... *Order No.*.....

Week Ending.	Drawing Room. Hours.	Drawing Room. Amount.	Patterns. Amount.	Castings. Amount.	Stock. Amount.	Machine Shop. Hours.	Machine Shop. Amount.
Aug. 7	4½	$1.80	$71.75	$16.45	$13.20	7	$0.58
" 14	22½	8.90	5.50	121.25	8.60	247	45.63
" 21	14¼	5.70	4.25	12.00	.....	281	42.84
" 28	9	.10	.....	.....	.....	228	31.63
Total...	50	$16.50	$81.50	$149.70	$21.80	763	$120.68

Drawing-Room Time.....	50	General Expense.....	$213.25
Machine-Shop Time.....	763	Drawings.....	16.50
Total Time.....	813	Patterns.....	81.50
Hourly Burden.....	.25	Castings.....	149.70
	4065	Stock.....	21.80
	1626	Labor.....	120 68
General Expense.....	$213.25	Cost.....	$603.43

operation; *i. e.*, all turning upon piece marked 6 *A* 2, are entered under "Turning" on the labor sheet, Fig. 8, which, in order to save room, is printed with two headings only, turning and planing. In reality it should contain all the operations done in the shop, together with a "total." So, also, with each of the other classifications, each line on the sheet showing not only the cost of a certain piece, but the cost per operation.

This, then, is the "hour-wage" method of determining cost; and while it falls short of the ideal system for which so many have labored, its free adoption would go a long way toward the salvation of those manufacturers who, though at present favored with their full share of orders, are destined sooner or later to be dropped from the list of the successful through their lack of a proper appreciation of the cost of production.

FIG. 8.
AVERAGE COST PER OPERATION OF LABOR PER PIECES FOR ONE MACHINE.
Shop Order No. 1788.

Symbol.	Pieces.	Turning. Ticket.	Turning. Hrs.	Turning. Amount.	Planing. Ticket.	Planing. Hrs.	Planing. Amount.
6 A 1	6		3	30			
6 A 2	6		2¼	45			
6 A 3	6		4	64			

A HEAVY DROP HAMMER.

We illustrate herewith a drop hammer recently erected by the Billings & Spencer Co. of Hartford, Conn., which is believed to be the largest in existence. Up to the last few years the practice has been to build the base or anvil block from 6 to 8 times the weight of the hammer head, and owing to the light base and comparatively light construction, it has been considered necessary to construct a foundation having some degree of elasticity, so that wooden logs have been placed underneath the base for a cushion. In the hammer illustrated this method has been entirely departed from, the base in this case being in the first place 20 times the weight of the hammer head and heavy enough to stand the vibration. This base is set on a foundation of Portland cement incased in a wrought steel box 5 x 9 feet, which weighs 30 tons. The bottom section of the base or anvil is fastened to the foundation by 4 anchor bolts passing clear through

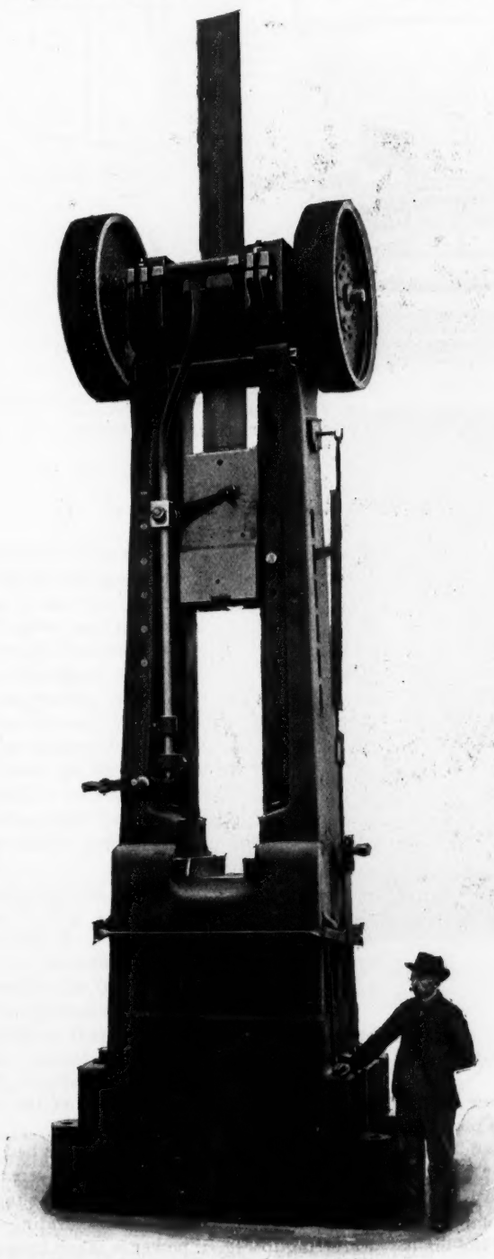


FIG. 1. 3 000-POUND DROP.

the concrete, and between the foundation and base has been placed a solid sheet of lead ¼ inch thick.

Before building the hammer a series of experiments was carried on during a period of two years to demonstrate whether a rigid foundation would give better results in practice than the old form of elastic foundation and if so, how much better. Two drop hammers standing side by side were used in these experiments, identical in every respect except as to the weight of the base, which in one case weighed 9 000 pounds and in the other 18 000 pounds. The hammer head weighed 1 100 pounds. Among the experiments tried was the effect of the two hammers upon copper specimens one inch in diameter and one inch long. One of these specimens is shown in Fig. 2 and in Fig. 3 is seen the way it appeared after it had been struck with the hammer having the 9 000 pound base. In Fig. 4 is seen the way one appeared when struck with the hammer having the heavier base. In the first case the thickness after the blow was $\frac{15}{32}$ inches and in the latter case $\frac{9}{32}$ inches, showing an increase of about 40 per cent. in favor of the heavy base.

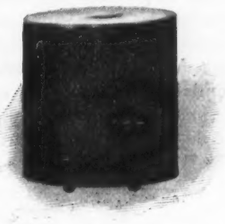


FIG. 2.

To obtain a more exact idea of the force of a blow thus obtained, the same size piece of copper was placed in a Sellers testing machine and compressed to the full capacity of the machine, 50 tons, the result being a greater thickness than that secured by one blow on the hammer having a light base, as shown in Fig. 5. A further indication of the power in each case was also noticed in connection with the heating of the specimen, that resulting from the blow of the hammer being too hot to handle, while the piece from the testing machine was as cool as before. While it might be expected that the specimen in the testing machine would not heat as much as the one under the hammer, the fact that the temperature was so much greater in one instance than in the other at least indicates that there was a considerable difference in the force expended in the two cases. It is also well known that a resisting body requires more power to compress it at a high rate of speed than when the compression is made slowly as in a testing machine.

FIG. 3.

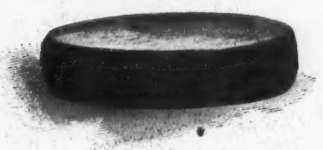


FIG. 4.

The large hammer illustrated in Fig. 1 has a weight of hammer head of 3 000 pounds; weight of base, 60 000 pounds; extreme fall, 6 feet 4 inches; shortest automatic fall, 31 inches; diameter of pulleys, 48 inches; face of pulleys, 10 inches; height from floor to tops of pulleys, 16 feet 9 inches.

A CORRECTION.

In the article "How to Design and Construct Electrical Machinery" in the December issue, Mr. Baxter in his directions for determining the size of wire for armature and field, says "it is safe to assume that in the armature the wire will carry at the rate of one ampere for every six or seven circular mils. of cross section, and the same figures may be used for field wire." If this were changed to read "six or seven *mils. of diameter*" instead of circular mils. of cross section, the rule would be correct. CHAS. A. SCHUM.

FIG. 5.

We referred the above letter to Mr. Baxter, who replied as follows: (ED.)

"In answer to the above will say that the rule, as printed, is not correct, but will be if made to read hundredths, instead of mills, thus: 'The carrying capacity will be at the rate of one ampere for every six or seven circular hundredths of an inch of cross section.' It may be well to add that this rule is only approximate, and holds good only for coils wound to a depth of less than three-quarters of an inch. With greater depth of wire the cross section should be increased proportionately.

As the cross section increases as the square of the diameter, Mr Schum's rule would be wrong for large wires. WM. BAXTER.

A GEAR SHAPER.

The action of the gear-cutting machine, of which a description follows, is based upon the principle that a gear tooth can be made to form its conjugate in a blank running in correct relations as to speed, center distance, etc., with the first wheel.

To accomplish this result, a gear is first produced that is as near to absolute perfection as is possible. This gear is then used as a planing cutter, being given a reciprocating motion back and forth over the face of the blank. At the same time the cutter and the blank are slowly rotated together at an equal pitch line speed, presenting fresh metal to the cutter at each stroke. Continuing this until the blank has made a complete revolution, a gear is produced, whose perfection is entirely independent of any errors outside of the machine itself. For example, in the ordinary gear cutter each cutter is made to do service for a number of sizes of gears, although for a strictly perfect gear each diameter should have a different form. These cutters, moreover, become distorted somewhat in the process of hardening, as do also the forming tools used to make them. While the inaccuracies resulting from these causes may not be very serious in practical work, it is, of course, desirable to overcome them.

In the gear shaper one cutter will correctly form the teeth in a gear of any size, and the tooth of the cutter is ground after hardening in a special machine. It is evident that if a perfect gear were rolled on a perfect rack, each part of the working face of the gear tooth would come into contact with the corresponding face of its mating rack tooth. As the perfect rack tooth of involute form has a straight face, an emery wheel inclined at the proper angle can be substituted for one side of it. By controlling the movement of this gear by means of steel tapes, it can be given a rolling motion over the face of the emery wheel, which motion will correspond to the action of the imaginary gear with its rack. This is the process by which the cutter is ground in the special machine, and as a result the emery wheel generates an involute curve which is as nearly perfect as is possible to produce mechanically. The master template to which the ordinary milling cutter is formed is produced on this principle, and the advantage claimed for the gear shaper is that the correct curve is produced at the cutter, instead of being several operations removed from it.

The operations of the shaper may be divided into three parts; one giving a reciprocating motion to the cutter, one rotating the cutter and gear blank at their proper relative speeds, and one withdrawing the work from contact with the cutter on its return stroke. The mechanism for effecting these operations will be understood from Figs. 2 and 3, which represent respectively a front view and a side view taken from the right side of the machine as placed in Fig. 1.

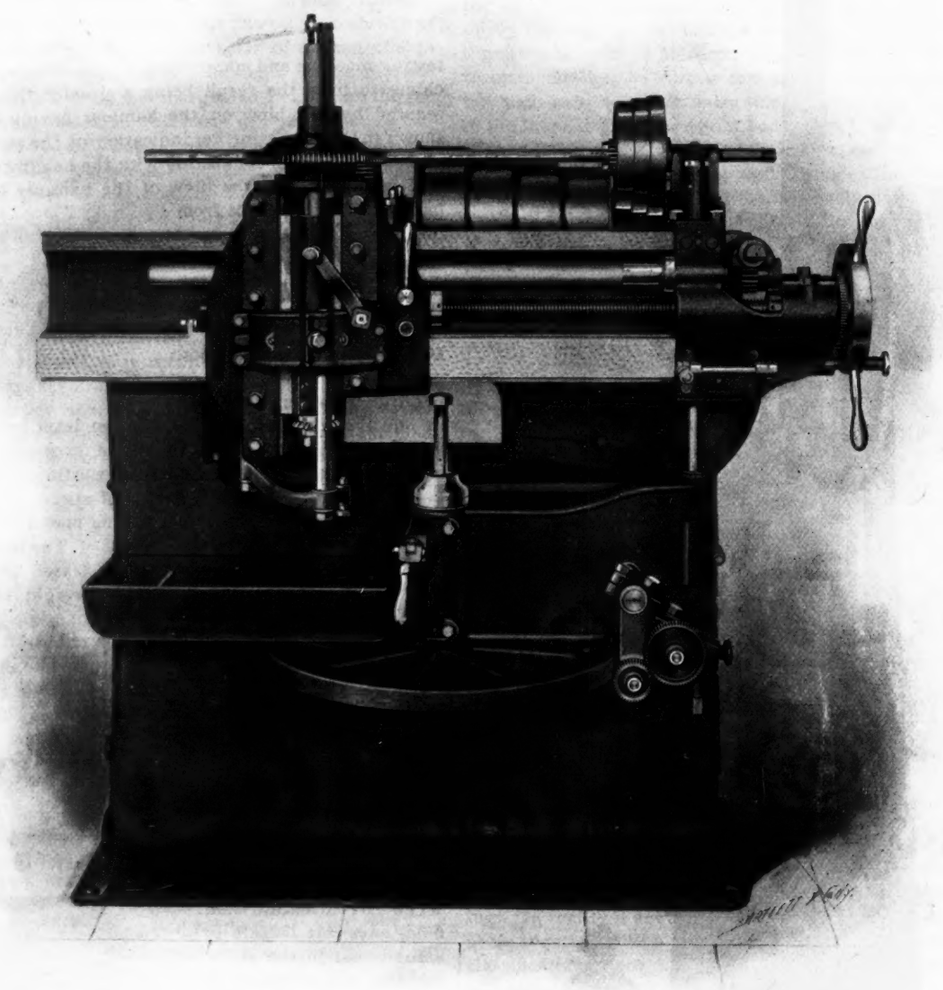


FIG. 1. THE FELLOWS GEAR SHAPER.

The saddle carrying the cutter bar is adjustable on the bed for different diameters of work, and the cutter bar is so driven that it has both a reciprocating motion, similar to the ram of a shaper, and a rotary motion for feeding the cutter and generating the teeth of the blank. Referring to Fig. 3, power is taken from the driving cone A, transmitted through the internal driving gear B to the driving crank C, giving a reciprocating motion to the rack bar D. This motion is carried to the cutter by means of the rock shaft E (Fig. 2), which drives a helical pinion engaging a rack on the cutter slide. The cutting may take place during either the upward or the downward stroke, but the upward or drawing stroke is preferable for most work.

The rotary feed is derived from the feed cone F, the cutter bar being rotated by the horizontal shaft G, seen in Fig. 2, which

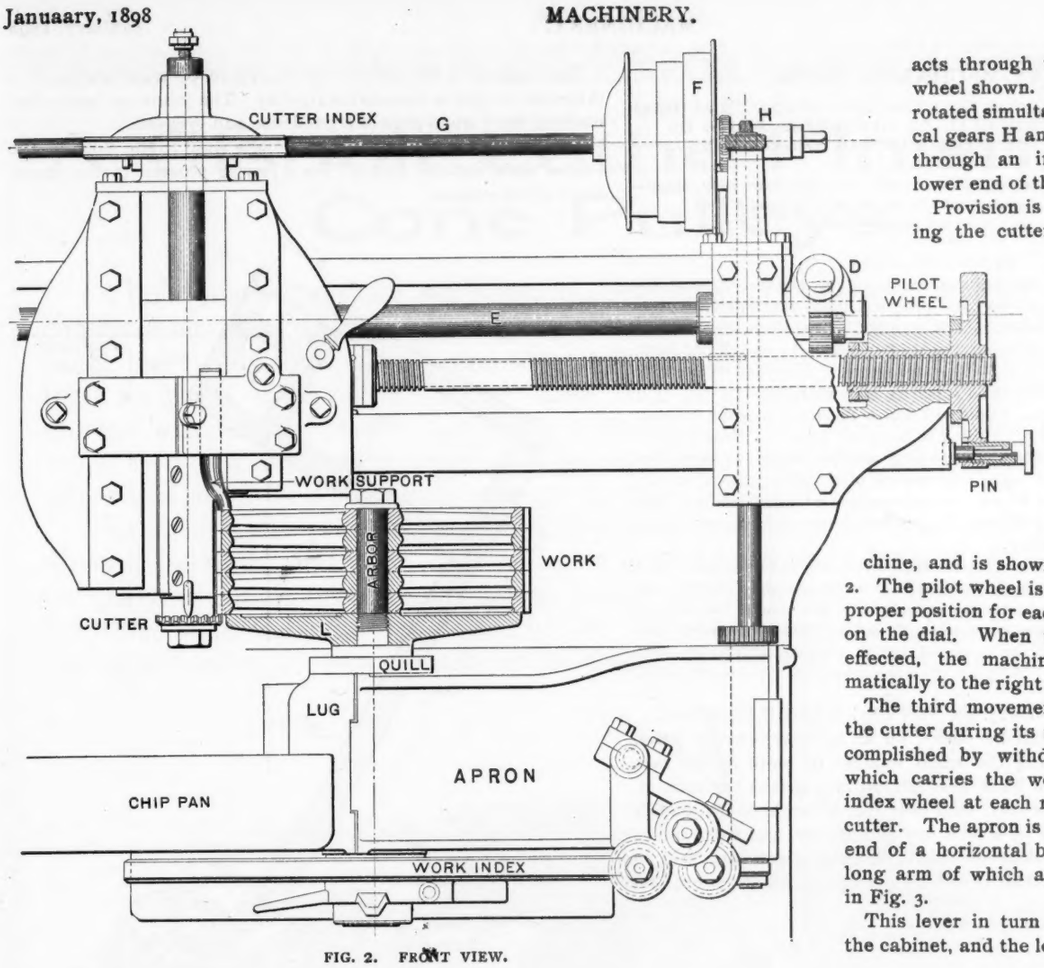


FIG. 2. FRONT VIEW.

acts through the worm or index wheel shown. The wheel blank is rotated simultaneously by the helical gears H and the vertical shaft, through an index wheel at the lower end of the work spindle.

Provision is also made for feeding the cutter radially into the blank to the depth of the tooth. The screw by which the saddle is held in position has a limited lengthwise motion, which motion is controlled by a nut which is an extension of the pilot wheel at the right of the machine, and is shown in section in Fig. 2. The pilot wheel is graduated and the proper position for each pitch is indicated on the dial. When the setting is once effected, the machine will feed automatically to the right depth.

The third movement, that of relieving the cutter during its return stroke, is accomplished by withdrawing the apron which carries the work spindle and its index wheel at each return stroke of the cutter. The apron is pivoted to the short end of a horizontal bell-crank lever, the long arm of which appears dotted at K in Fig. 3.

This lever in turn has its bearing in the cabinet, and the long arm receives an intermittent motion through the action of two cam-shaped plungers, one of which appears at P, Fig. 3, and the result is a slight movement of the apron, and hence the work, to and from the cutter. In order to secure perfect rigidity, part of the apron which forms a bearing for a quill supporting the work spindle is removed to allow the quill to have a partial bearing in a lug projecting from the frame of the machine. Each time the apron moves toward the cutter the quill is forced solidly against its bearing in this lug and therefore does not partake of any possible looseness or flexibility of the apron.

The method of holding the work is clearly shown in Fig. 2. The arbor has an inverted taper and is drawn into its seat by a face plate L threaded to it. The work is then clamped to the face plate, the whole making a rigid combination.

This gear shaper has recently been placed on the market by the Fellows Gear Shaper Co., Springfield, Vt.

* * *

THERE seems some prospect of worm gearing coming into favor again where a large reduction ratio is needed. Such gears have the advantage of being comparatively noiseless; but have, in the past, had an evil reputation for excessive frictional loss. More recent work with accurately made wheels has shown that this loss need not necessarily be very large. Various recent tests in this country and abroad have shown that with well designed gearing efficiencies toward 80 or 90 per cent. can be obtained. The idea that the efficiency must be below 50 per cent. because the wheel will not drive the worm is evidently falacious.

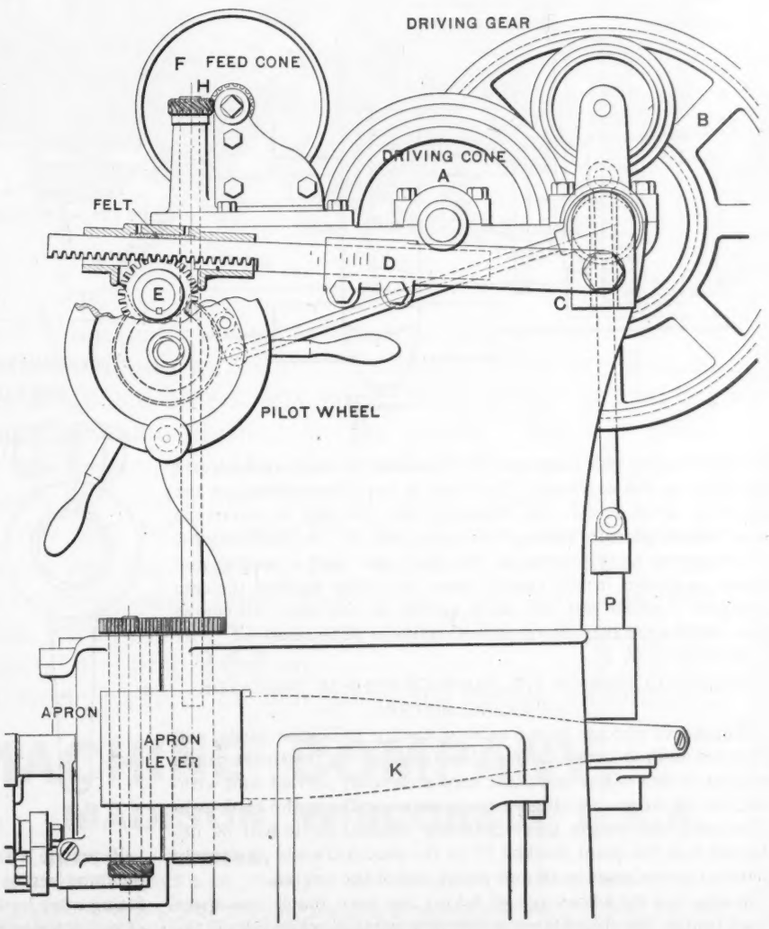


FIG. 3. END VIEW.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

READ THIS FIRST.

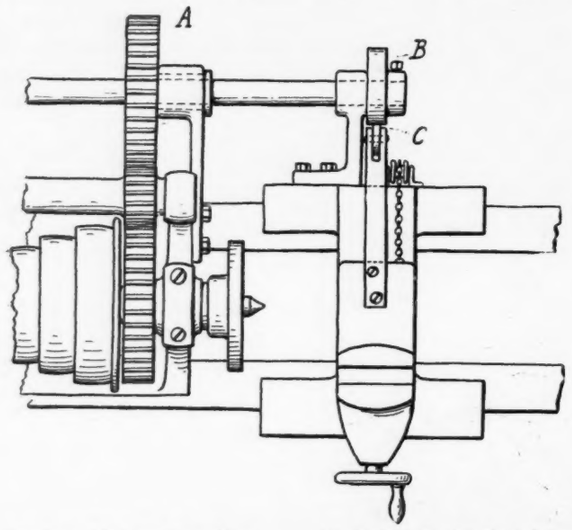
In accordance with the announcement in the December issue, the last installment of shop kinks and practical ideas sent in competition for the prize offer, appears in this number. Hereafter these will be paid for at the rate of from twenty-five cents to one dollar each, according to their value. By this arrangement everyone will receive full value for any contribution which he may send.

One machinist writes: "You will find a donation to your column, 'What Mechanics Think.' I think it is a good column. Nearly every body knows a few kinks worth reading, and they ought to send them along." This is one of many expressions of approval regarding this department that come to us. Of course it is a "good column," and for the reason that it is written by practical mechanics who are doing practical work in the shop.

Another letter states, "I am an apprentice, and awhile ago I saw a letter in the correspondence column from a companion in misery, and that gave me courage to try my luck at it." We should like to have every reader follow the good example set by this apprentice. Not everything sent us will be accepted, but it does no harm to try—two cents covers the cost. Why not give the postman more work to do?

LATHE ATTACHMENT FOR TURNING IRREGULAR WORK.

This attachment can be placed on an ordinary engine lathe. A spur gear A, having the same number of teeth as the face gear, meshes in the back gear pinion and drives the cam B, which is on the same shaft with gear A. When in operation this gear is held in place by a set screw and groove, and when not in use can be pulled clear of the back gear pinion and held in second place. The shaft is splined nearly the whole length and



is supported by two bearings, one attached to the headstock and the other to the carriage. The cam is kept from sliding on the shaft by a set screw, and whenever the carriage is moved the shaft slides laterally through the spur gear A. A small roller C is connected by a bracket to the tool rest, and a weight and chain, as shown in the sketch, keep the roller against the cam and give the tool rest the same motion as the cam. Of course it is understood that the cross-feed screw is to be removed.

Brooklyn, N. Y. T. B. C.

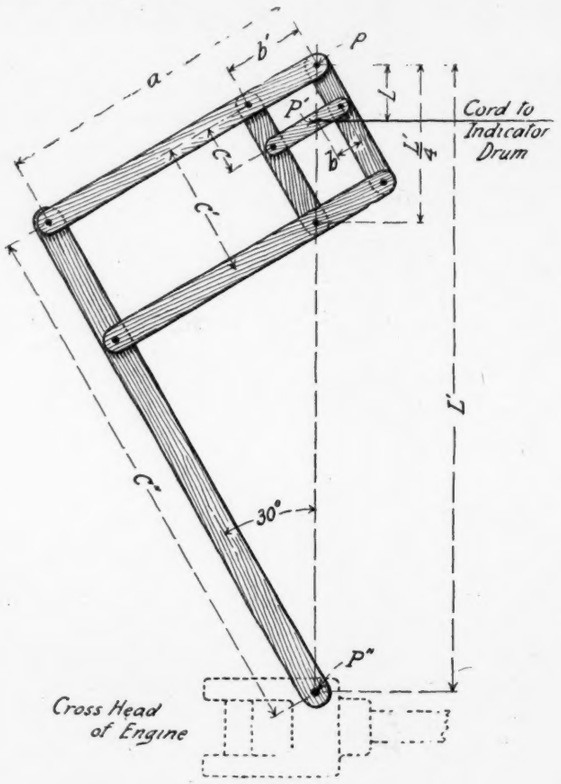
CONSTRUCTION OF THE PANTOGRAPH FOR INDICATOR REDUCING MOTION.

Engineers who are in the habit of taking indicator cards, will find the method herewith described for reducing the stroke of the engine to that of the indicator card absolutely correct and without the variations which give inaccurate results on the card, as in the case of the single lever reducing motion, for it will be observed that the point marked P^1 in the sketch travels absolutely parallel to the cross-head and piston rod of the engine.

It also has the advantage of taking up very much less space than that of the single lever reducing apparatus; especially if the engine has a long travel.

The rigging in the sketch can be made of wood strips, of a thickness to give a reasonable rigidity. The joints act best when made of hard wood pegs of a good size and greased.

The point P, is pivoted to a post made rigid to the floor of the engine room and the end P^{11} is likewise pivoted to the cross-head of the engine.



The cord is secured at one end to the point marked P^1, the other end to the drum of the indicator.

Let S be the length of stroke reduced to that of the indicator card and S^{11} equal the stroke. All dimensions are in inches. The proportion of the other parts of the apparatus are obtained as follows:

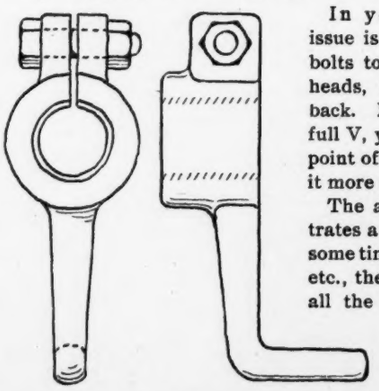
The Length L^1 is made any convenient length which the space on the scene of action will permit. Then:—

$$a^1 = \frac{L^1}{2}; \quad b^1 = \frac{L^1}{8}; \quad C^1 = .216507L^1; \quad C^{11} = .86603L^1;$$

$$L = \frac{SL^1}{S^{11}}; \quad b = \frac{.5\,SL^1}{S^{11}}; \text{ and } C = .86603\,\frac{SL^1}{S^{11}}$$

Hokendauqua, Pa. GEO. H. WALTMAN.

THREADED DRIVER FOR BOLTS AND STUDS.



In your September, 1897, issue is illustrated a driver for bolts to be used in facing the heads, which has one drawback. In case the thread is a full V, your driver binds on the point of the thread and injures it more or less.

The accompaning cut illustrates a driver used by me for some time for studs, bolt heads, etc., the thread being cut full all the way through, and it clamps the thread the full depth. B. L.

Douglas, Alaska

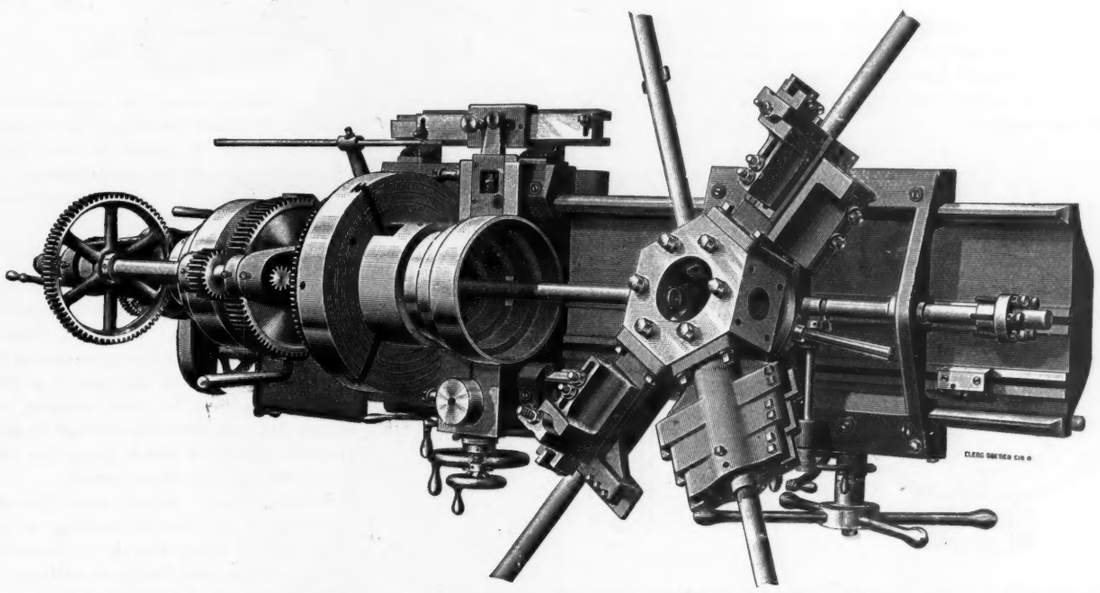
BORING AN ECCENTRIC STRAP.

Eccentric straps very often give trouble in manufacture by pinching across the top and bottom ends when taken apart for fitting after boring. Some builders have followed the practice of rechucking the strap twice and relieving the top and bottom sufficient to give the proper clearance. One well known firm of

A Gisholt Lathe Finishing Cone Pulleys.

A good many shops are still finishing cone pulleys by chucking and turning in an engine lathe, often driving the pulley by means of a dog clamped to the arbor driven in the pulley and turning each step separately by means of a single pointed tool, and if there are many cone pulleys to be made, such an arrangement is one of the greatest money losing schemes ever adopted in a machine shop. Other shops are attempting to use two or more tools at once in finishing their pulleys, but there are few engine lathes that are driven powerfully enough to stand the strain.

To finish cone pulleys **economically** they must first be held rigidly; second, driven powerfully, and third, operated upon with a number of tools at once. The accompanying cut shows a cone pulley as held in a Gisholt Lathe which is to be chucked and three steps to be finished on the inside. The first tool employed is the one for boring and facing the inner surface of the three largest steps.



The operations and tools vary to a greater or less extent according to the design of the pulleys. Some pulleys are only bored and turned on the outside, others are finished all over, some have the bore very small and others very large. The pulley shown has 3½ inch bore and the three large steps are finished on the inside. The cut above shows the first operation. The first tool employed is the one for boring and facing the three largest steps. Double cutters are used in this tool, which is rigidly fastened to the turret face and steadied on outer end by a supporting bar which fits bushing in chuck. The second and third tools are the roughing and finishing boring bars, each supported at outer end in chuck bushing, when doing their work. The fourth and fifth tools are our standard facing heads with finishing and sizing cutters for boring and facing the largest step. This completes the first operation.

If interested in this class of work, write us for blue prints and further information.

GISHOLT MACHINE COMPANY,

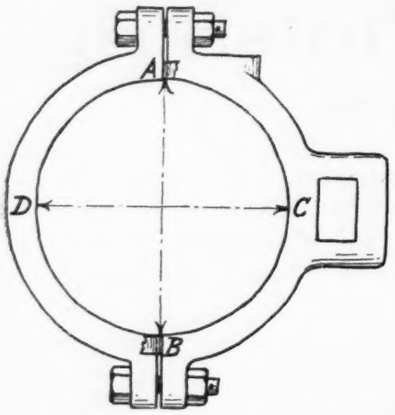
EASTERN BRANCH, WALTER H. FOSTER, MANAGER,
126 LIBERTY STREET, NEW YORK.

MADISON, WISCONSIN, U.S.A.

GENERAL AGENTS:

C. W. BURTON, GRIFFITHS & CO., London. FENWICK FRERES & CO., Paris. SCHUCHARDT & SCHÜTTE, Berlin, Vienna.

engine builders at least has adopted with good results the practice of putting strips of tin between the ends of strap as shown in sketch at A and B. When the bolts are drawn up tight the effect is to lessen the diameter A B and to lengthen C D. After boring, the tin strips are removed and the ends spring apart, giving sufficient clearance to avoid the trouble referred to.



Another point which will give annoyance is chucking the strap so that the center of the bore does not come on line of division of the two parts. If center of bore is to one side it makes one part longer than the other, or more than a semi-circle.

FRED E. ROGERS.

Corning, N. Y.

MORE ABOUT ECCENTRIC STRAPS.

To bore eccentric straps so they shall not close in at *a a* when bored:

First plane and scrape together, drill and ream bolt holes and fit bolts, then put between faces about $\frac{1}{16}$ tin liners and a couple of papers, full length from *a* to *c*. Then put in one piece packing paper about ¼" wide from *a* to *b* when bolts are tightened, *a a*, will spring together.

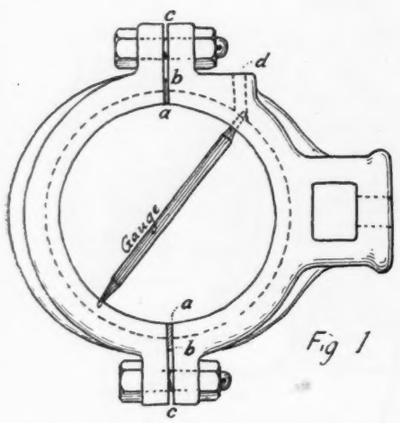


Fig 1

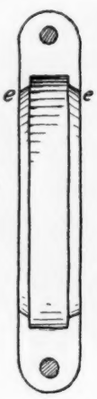


Fig 2

Face one side in chuck then clamp against face plate strips and bore. When liner *a a* is removed, straps spread between *a a*.

When the straps are made female and the hub male, I use a gauge made of ¼" round steel, straight, which can be slipped up oil hole *d*, letting the gauge inside the flanges to caliper. Straps are bored $\frac{1}{64}$" wider than hub F, Fig. 2.

The flanges are chambered, E, Figs. 2, 3, to keep the oil on eccentric.

U. P. LANG.

Meadville, Pa.

[The artist evidently represented the pieces from *a* to *b* ¼ inch *thick* instead of ¼ inch *wide*, in Fig. 1.—ED.]

GRINDING IN VALVES.

In your November issue, Apprentice Boy writes of grindstone dust for grinding valves. Unless his grindstone is of much finer grit than any I ever saw, I don't want any valves ground with it. Flour of emery (of the finest grade) will give a better joint than the average grindstone dust. True, the emery would probably last longer and grind longer, but the grindstone dust seems to have a vicious way of giving a seat "a high polish and a deep scratch" as the boys used to say.

For fine valves, we used either "quartz" (really pulverized glass) or "brickyard sand," which we got around brick-yards and which seems to be a mixture of fine sand and clay. This had very little grit and made an excellent job.

In some cases we began a seat with emery until we got it "roughed" down to a bearing, then wiped the emery off carefully, and finished with this fine sand.

We tried using grindstone dust, but finally decided it did more good to throw it away than to try to use it.

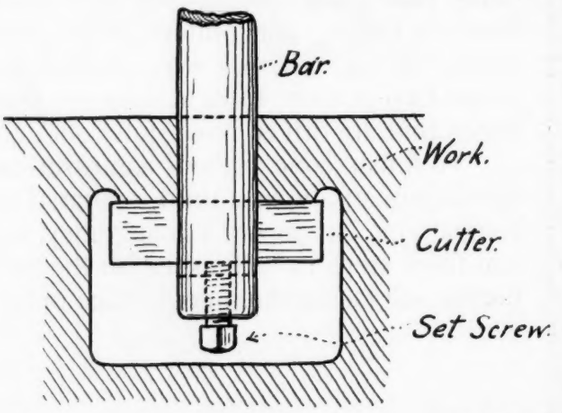
If you want a really good valve, it pays to grind it in right and to use the best abrasive. It doesn't pay to slight it, or to do it by hand (when making in quantities), but it does pay to give it enough attention to make a good job, as a leaky valve is a continual annoyance to the user and a continual disgrace to the maker.

BRASS WORKER.

Hoshkosh, Wis.

A DEVICE FOR CUTTER BARS.

I give herewith (shown below) a handy device for cutter bars which could be utilized with advantage where a cutter has to be



used in an unhandy place where it would be impossible to insert a key. Besides it would be easier to adjust the cutter and to keep it square. It would be very handy in a job like the one shown in the sketch.

FREDERICK BIRDSALL.

San Francisco, Cal.

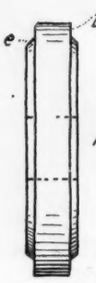


Fig. 3

KEEP THE SHAFTING IN LINE!

While waiting for a train one afternoon at Oneida, N. Y., I stepped into the machine shop of Liete & Loomis. When six o'clock came the engine was left running to enable one man to finish milling a ⅜" keyway in a shaft that was to be called for that evening, and the power did not diminish enough to attract his attention until the steam gauge on the boiler indicated less than three pounds.

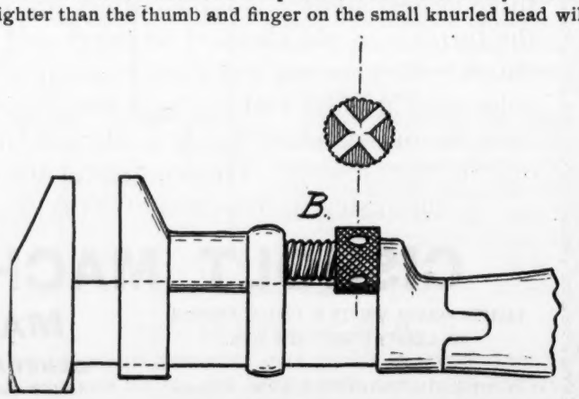
Noticing this I looked about the shop and found about 200 feet of shafting in operation about half of which was 2½" in diameter, from which twenty-four belts of ordinary size for such shops were running on the loose pulleys of various countershafts and machines. There were nineteen bearings on the line shaft.

Train time prevented me noting further detail, but it seemed to me that the shafting in that shop runs pretty easy. What do others think?

MILO.

IMPROVING A MONKEY WRENCH.

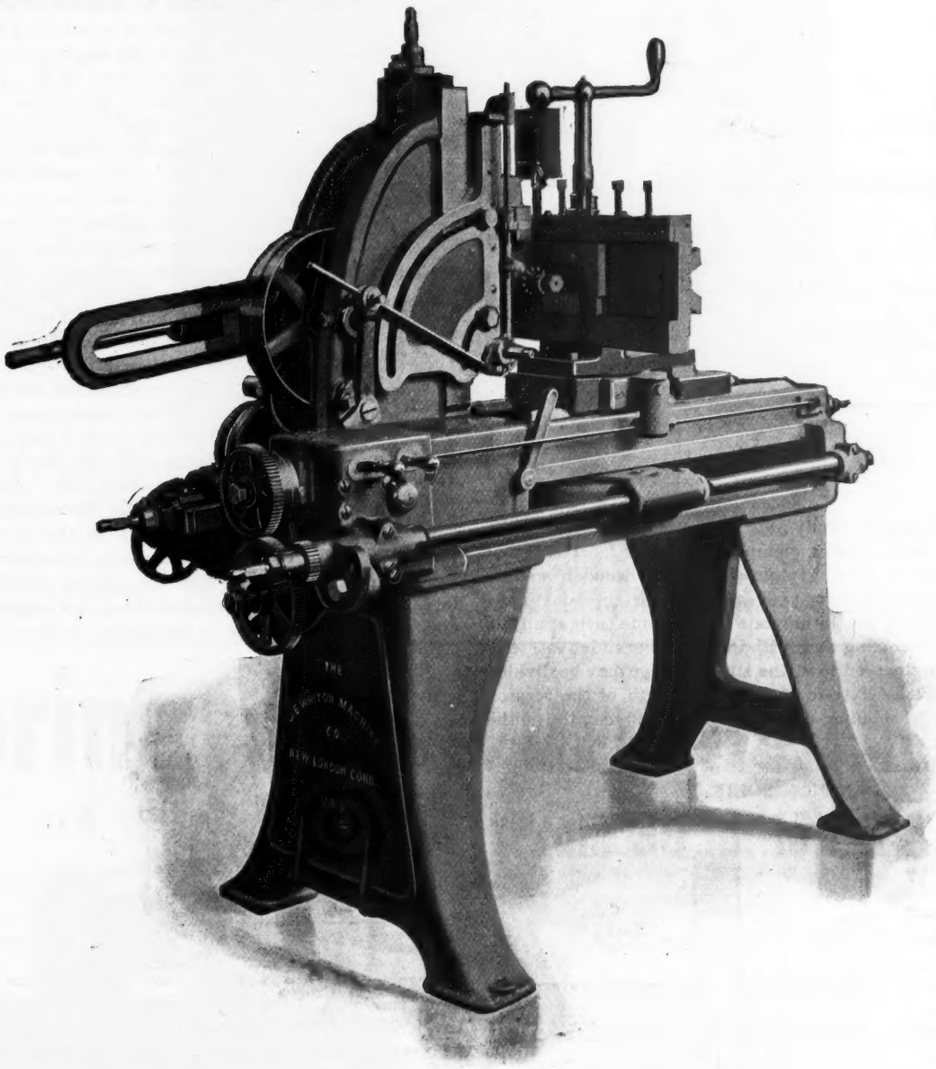
Oftentimes we want to set up the jaws of a monkey wrench tighter than the thumb and finger on the small knurled head will



permit. In the accompanying sketch the knurled head B of the adjusting screw has two holes drilled through at right angles to

The best Gear Cutter for all-around shop use.

Besides being adapted to cutting spur and bevel gears, the Whiton Automatic Gear Cutter can be used for rack cutting or for hobbing worm wheels, making it a machine that is distinctly an all-around shop tool. The engraving shows the gear cutter with the rack, cutting attachment in place. With this attachment the length of the rack which may be cut at one setting is limited only by the construction of the sliding carriage in which the rack is held.



For hobbing worm wheels, a patented arrangement of the spacing gears is provided by which the cutter arbor and the index wheel can be run continuously in unison and the machine made to hob worm wheels without nicking the blanks.

Other attachments can be supplied adapting the machine to special purposes if desired; but whatever the attachment, the special features which have made the Whiton Gear Cutter so successful are operative.

No friction devices of any kind are used. Each movement depends upon the completion of a previous movement and cannot start in operation until the previous movement has been completed. There is but one driving belt, which requires no tightener. The full power of this belt is used successively for the different movements and is not wasted in driving any part of the mechanism when such mechanism is not required.

Full particulars furnished by the manufacturers,

THE D. E. WHITON MACHINE COMPANY,

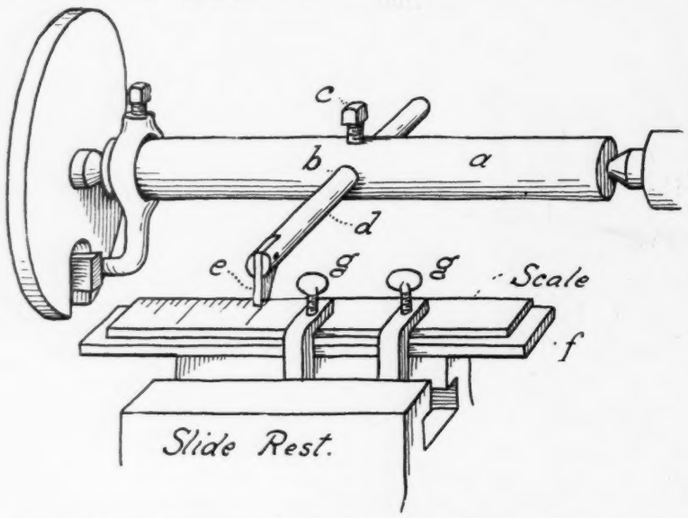
No. 54 Howard Street, New London, Conn., U. S. A.

each other, making four places on the periphery, by the use of which in connection with a pin, a leverage is secured and the jaws may be clamped firmly upon a worm bolt-head or nut, with results that cannot be obtained with the ordinary tightening of the jaws. I also find it handy in a great many ways. In fact it is a veritable combination monkey wrench and hand vise.

Providence, R. I. JOHN W. BROADHEAD.

GRADUATING SCALES.

Home-made straight-edges may be graduated by the following apparatus. Referring to the cut, *a* is a steel bar centered on ends; *b* a ½-inch hole, filed V-shaped on bottom; *c*, set screw; *d*, ½-inch round steel bar; *e*, the diamond tip of a glass cutter. This is fastened securely to the end of *d*; *f*, a planed bar of iron or steel about 1¼ x ½; *g g*, clamps.

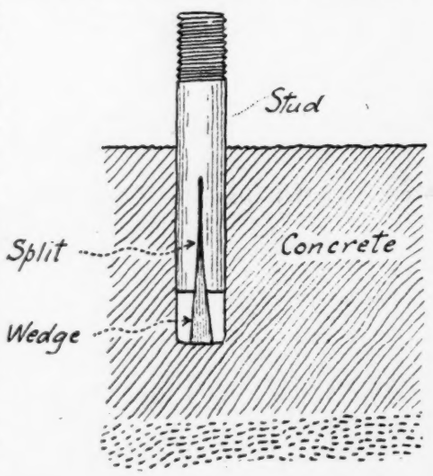


Close the lathe centers firmly on *a* and set the apparatus up as shown. The straight-edge is clamped on top of *f*. The tail of the dog is wedged in driving plate slot with a wooden wedge. Put in screw gears for thirty-two or sixty-four threads to the inch; then by turning the lathe cone around one turn at a time and alternately advancing and withdrawing the slide-rest, with the straight-edge clamped to it, the straight-edge may be divided into thirty-seconds or sixty-fourths. The length of the scratch is governed by the number of turns of the feed handle of the slide rest. F. F. DORSEY.

Winchester, Mass.

ANCHOR BOLTS.

In the November issue, "J. T." had an anchor bolt for a brick wall which might be strong enough to hold a weight, but could not be used as well to bolt heavy machinery to con crete. Where we have used heavy tools the concrete was 8 inches thick. We drilled 6 inches into the cement with 1¼ drills, then took a bar of 1¼ round iron, split it and just entered a wedge (see sketch). The other end was threaded for a nut, the stud was put into its place and a few blows of the sledge made a taper head at the end never to come out. F. E. G.



San Francisco, Cal.

* * *

THE success of this department depends upon the amount of help given by its readers. Let us have more letters than ever next month

CLEARANCE AND COMPRESSION.

Allow me to protest against the extremely one-sided discussion of the question of steam-engine clearance by Mr. Hemenway in your issue of November. Mr. Hemenway is misleading in that he fails to point out the effect of clearance upon the expansion curve. Thus, in Fig. 1, let A B C D be the indicator card of an engine without clearance, but expanding to the level of back pressure D C before exhausting. A B measures the steam taken in and area A B C D the work done.

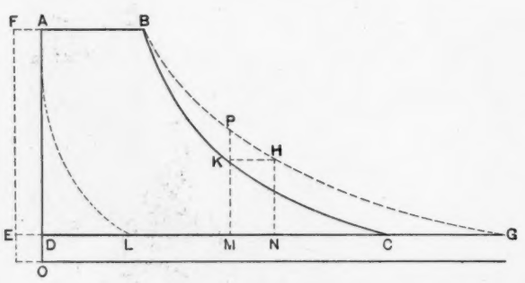
Now, if clearance be added, as shown in the dotted lines, but without compression, F B measures the steam taken in and area A B C D the work done; or the loss is some fraction of the steam necessary to fill the clearance F A.

If complete compression be added, as along L A, the steam consumed is measured by A B and the work done by A B G L. Since this last is equal to A B C D the efficiency is equal to that of the engine without clearance.

All this is doubtless no news to Mr. Hemenway, but it may be assumed to be to his pupils; and he cannot be said to have given either a clear or a fair or a useful statement of the question unless he emphasizes this primary statement, viz: *That compression and expansion being complete, clearance in any amount has no effect upon the theoretic efficiency.*

The next statement essential to clear thinking through such problems is: *That expansion being incomplete clearance exaggerates the loss.* But the loss is clearly due to incomplete expansion, and not to clearance; for the completion of expansion will eliminate all such loss, while the abolition of clearance will not.

Secondly, in actual practice the net result of clearance is sometimes a loss, sometimes a gain. If the clearance be chiefly in the form of ports and chambers, presenting much surface to the steam in comparison with their volume, the loss from condensation will overbalance any gain. If, on the other hand, the clearance be added to the waste space in the cylinder, between piston and cylinder-head, the increase in surface exposed is insignificant in comparison with the volume added—for the surfaces of piston-end and cylinder-head are exposed in all cases and merely the increase in peripheral surface is chargeable to



clearance. In this case, the compression of the cushion-steam along the line L A tends to superheat the steam and to raise the temperature of the surrounding surfaces towards boiler-temperature, the result being that initial condensation is decreased and there is an actual gain in efficiency where none is promised in theory.

Thus, no prediction can be made as to the result of a given increase in clearance. Sometimes it is good, sometimes it is bad. But recent steam engineering progress has shown results too striking in engines having considerable clearance, and which, indeed, as Prof. Osborn points out, smash nearly all the old-fashioned rules-of-thumb in engine-design—to permit the questions being disposed of in the way adopted by Mr. Hemenway.

Worcester, Mass. SIDNEY A. REEVE.

MR. HEMENWAY'S REPLY.

Mr. Reeve is very evidently enjoying the satisfaction of discussing the article to which he refers without having gone to the trouble of reading it. If he will take the time to read for about one minute he will find Fig. 6 credited with a work area of 2.53 square inches, against 2.38 square inches for Fig. 5. If I take no account of the influence of clearance, as he says in effect, what accounts for this increase in work area?

Mr. Reeve quotes presumable authorities on steam engineer-

Combined Vertical & Horizontal Spindle Milling Machine

Capacity.

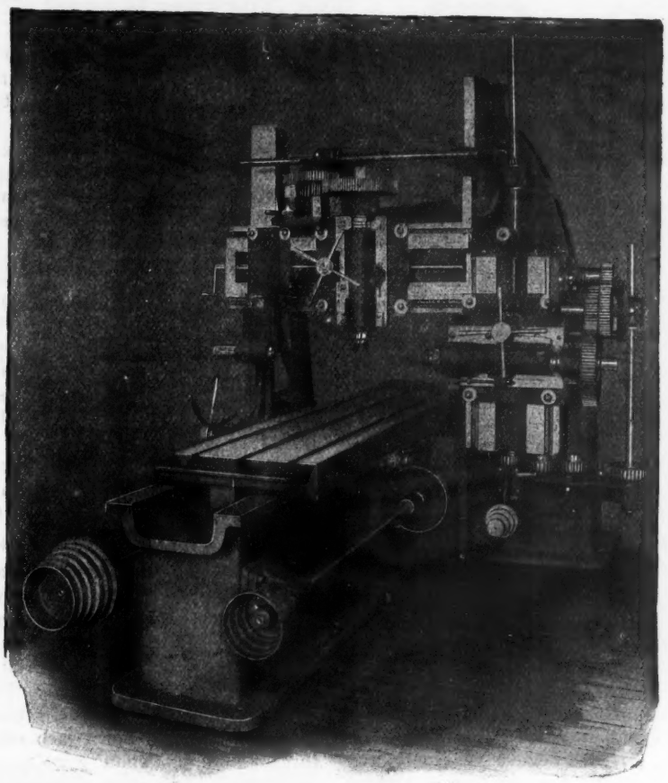
From COLUMN to detachable outer support for cross head, 40 in.

From top of TABLE to end of vertical spindle from 0 to 50 inches.

The HORIZONTAL SPINDLE has 36 in. vertical adjustment and outer support for slab milling.

The VERTICAL SPINDLE has 24 in. horizontal movement on cross head and suitable automatic feed and stop in either direction.

The TABLE is 24 in. wide and 8 ft. long, with T slots and end pockets.



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General Adaptability

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The SPINDLES are strongly driven, and can be run in unison or independently.

The TABLE is provided with ample feeds and automatic stop. Also quick power movement in either direction.

A REVOLVING TABLE for circular work furnished if desired.

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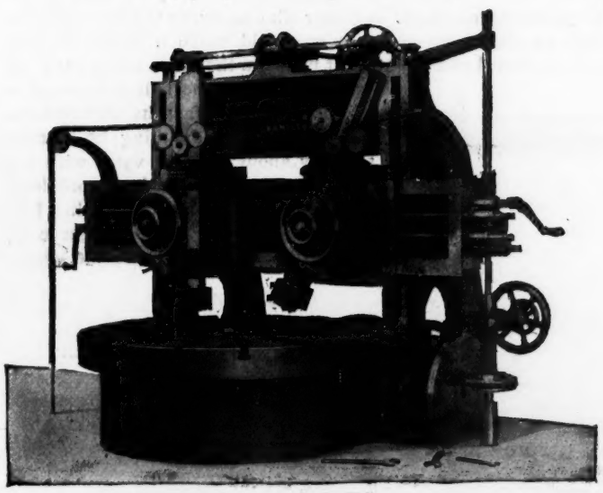

60 INCH BORING AND TURNING MILL.

Heads arranged right and left, so they can be brought close together. Tool holders solid steel forgings. Bars octagonal section. Spindles made extra long and provided with adjustable bush...

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WORKS: Hamilton, Ohio, U. S. A.

ing with pleasing fluency. Against these I have already put a few simple figures in arithmetic which are both "clear" and "fair," and which I believe give strictly accurate results.

It was plainly enough intimated that the diagrams shown were not for purposes of calculation.

Further discussion of the subject would doubtless be neither profitable nor entertaining to the readers of your paper, hence I shall say no more. F. F. HEMENWAY.

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

41. V. A. E. writes: What curve or crown is usually given to the face of pulleys in order that the belt may run to the center? *A.* There is no uniformity in respect to this. Perhaps a taper of ¼ inch per foot for pulleys of 4-inch face and upwards and a little more, say ⅜ inch per foot, for narrow faced pulleys is as good practice as any. A curved face is a little better than a straight taper.

42. J. H. asks: Is there any way of making and hardening taps so that they will not spring in hardening? I have had more or less of this trouble and have not been successful in avoiding it. *A.* Try annealing the steel two or even three times, taking a cut over it between each annealing, leaving a light cut for the last or finishing cut. This is not an expeditious way of making taps of the kind you mention, but it is likely to prevent springing in hardening. If it does not, leave a light cut for the outside and nearly finish cutting the thread before the final annealing.

43. H. B. asks: Where can I obtain iron or steel pipe that is as smooth, straight and accurate outside as cold rolled shafting? It must be ½" or ⅝" outside diameter, with a hole about $\frac{5}{16}$". Length must exceed one foot. *A.* We believe your only way will be to drill the tubes from the solid bar and turn and grind the outside afterward. A cheap and efficient method of drilling tubing is described in the shop notes in this issue. The Krupps, of Germany, whose American agents are Thos. Prosser & Sons, N. Y., make a good quality of drawn tubing, but our experience with it is that it is inferior to cold rolled steel.

44. A. B. C. asks: I do not fully understand about the braking power of a train mentioned in your last number. I should suppose that if the wheels were held fast, or the engine reversed, the train would stop sooner than if the wheels were allowed to slip, but of course, know it is not so. Why is it? *A.* When the wheels revolve there is friction between the circumference of wheel and the brake shoe, the surface of which is considerable, as well as the velocity of wheel. When the brakes are applied so hard as to slide the wheels, there is sliding friction on points, as it were, which it has been determined, experimentally, is about 50 per cent. less effective in converting the motion of the train. Reversing the engine is dangerous to its mechanism and is only reverted to under emergent circumstances.

2. Why has not some form of reversible tool holder for planers come into general use? It seems to me that the time taken for running back is worth saving. *A.* Reversible tool holders for ordinary planers have at various times been tried, but we do not know of any in present use, the reason for which appears to be rather apparent. However fine the construction, the wear of parts of their mechanism would soon bring about cutting a little deeper in one direction than in the other. To be sure the reversing arrangement might be disconnected for the finishing cut, but then the return motion would be so slow as to counterbalance any advantages.

45. C. H. J. asks: In hardening [tempering] a tool such as used for planers and lathes, what color should it be when it leaves the fire, and what is the further process of hardening? *A.* The tool to be tempered should be heated to a fairly bright red heat, and quickly immersed in cold water to a little below the depth it is required to be hardened, moving it up and down a little while cooling. The fire should not be of fresh coal; that is, not a fire freshly made or replenished, but one in which the fresh coal has had time to coke. After that part of the tool that should be hardened has had time to become cold, remove from the water. The temper must then be "drawn." For this purpose hastily rub the part, or a portion of it, that is to be tempered, with an emery stick or a piece of grindstone, so as to observe the color as it "runs down." There may be heat enough in the shank of the tool to draw the temper. If so, all the better; if not it must be warmed a little in the blaze over the fire, applying the heat below the part that requires to be tempered. For large planer tools, and for some blunt lathe tools, the color, in tempering, is just started, being left at a light straw color, while for others, especially lathe tools, it is allowed to run down to different shades of yellow and even to purple. This to prevent breaking. A good deal of experience is required to judge of the proper color for tools for different purposes. In heating to harden, the heating should be moderately slow and as even as possible. The temper should be let down very gradually. When the right color is reached, plunge the whole piece instantly into the water.

46. B. L. writes: I have been unable to find tables that give the standard sizes of gas pipe threads. I should like to know what is the standard at the top and bottom of threads and how far from the end of the pipe the measurement is taken. *A.* Very complete gas pipe tables are published in Kents' pocket book and doubtless you will find such tables in the catalogs of steam fitters' supplies, such as issued by the Walworth Manufacturing Company, of Boston. The diameters at top and bottom of thread are generally measured at the small end of the taper. The diameter at the bottom is given by the formula

$$D - (.05\,D + 1.9) \div n$$

where D = outside diameter pipe and n = number of threads per inch. Expressed as a rule it is, multiply the outside diameter by .05 and add 1.9 to the result. Divide this sum by the number of threads and subtract the quotient from the outside diameter. Example: What is the diameter at the bottom of the thread at the small end of a 2-inch pipe? The outside pipe diameters are very irregular, but these and the number of threads are given in gas pipe tables. For 2-inch pipe, diameter = 2.375 and no. threads = 11.5. Then, $2.375 \times .05 = .119$; $.119 + 1.9 = 2.019$; this divided by 11.5, the number of threads, $= .175$ and $2.375 - .175 = 2.2$ ans. To get the diameter at top of thread, divide 1.6 by the number of threads and add it to the diameter at the bottom. Thus, in the above example, $1.6 \div 11.5 = .139$; $2.2 + .139 = 2.339$ ans.

2. Haswell gives 19 threads for ¼ and ⅜ inch pipe and 11 threads for from 1 inch to 2 inches. Where are those pitches used? *A.* We do not know; 18 and 11½ are the standards.

47. L. V. R. writes: Please tell me if there is any simple way of working out safety-valve problems? I have tried to study formulas, but do not understand them. *A.* We used to be acquainted with an old engineer who, knowing the weight of the ball on the safety-valve lever, would make a sketch on any smooth board and tell at what pressure the valve would blow off or where to place the ball to blow off at any pressure. In fact, he seemed to be able to find out anything he wanted to know about a safety valve with but few figures. He worked the problems by means of a sketch something like Fig. 1, in which the broken lines serve no other purpose than to make the matter

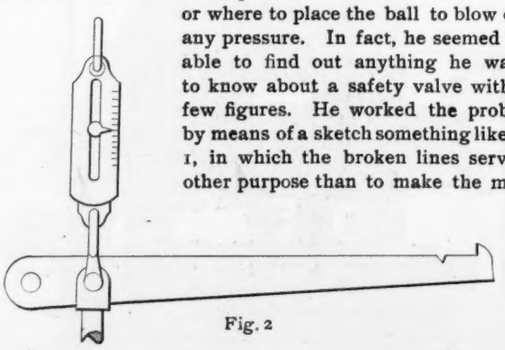

Fig. 2

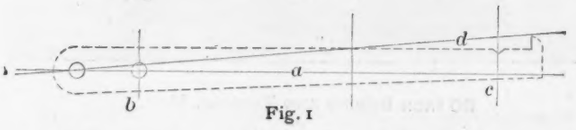

Fig. 1

plain. The line *a* is drawn horizontally through the center of holes in the lever, and continued for a convenient distance, the valve being supposed to be seated. Lines *b* and *c* are drawn at right angles to line *a*; the first assumed to be drawn through the vertical center of the safety valve, and the second through the center of gravity of the ball. Line *d* is drawn at any convenient angle, for example, so as to cut line *c* at a vertical dis-

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160 REAR HUBS, DRILLED, FORMED AND NECKED, IN 10 HOURS.

AND WE CAN DO IT AGAIN.

ONLY ONE FORMING TOOL TO KEEP UP.

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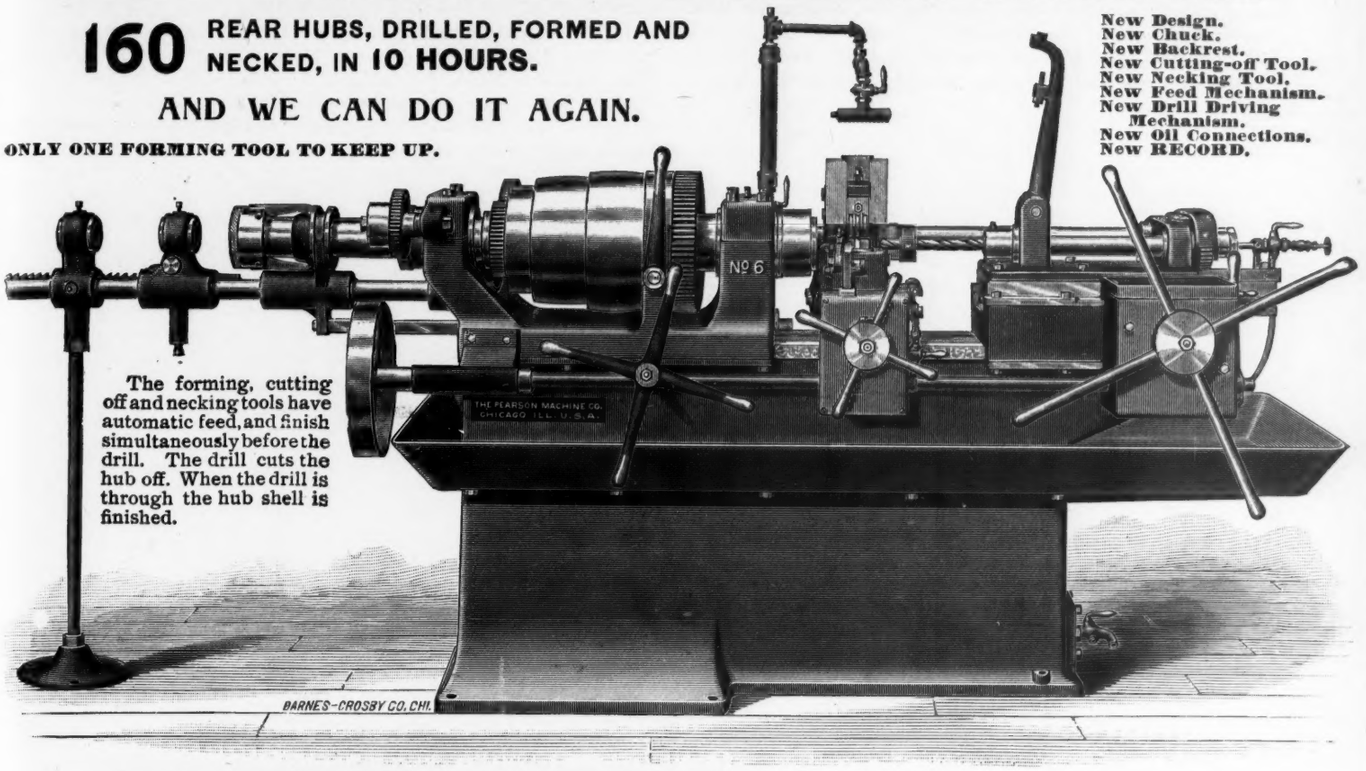


The forming, cutting off and necking tools have automatic feed, and finish simultaneously before the drill. The drill cuts the hub off. When the drill is through the hub shell is finished.

THE PEARSON MACHINE CO., 31 W. Randolph Street, Chicago, Ills.

H. RICHTER, Berlin, Agent for Germany.

See preceding issues of MACHINERY for detailed description.

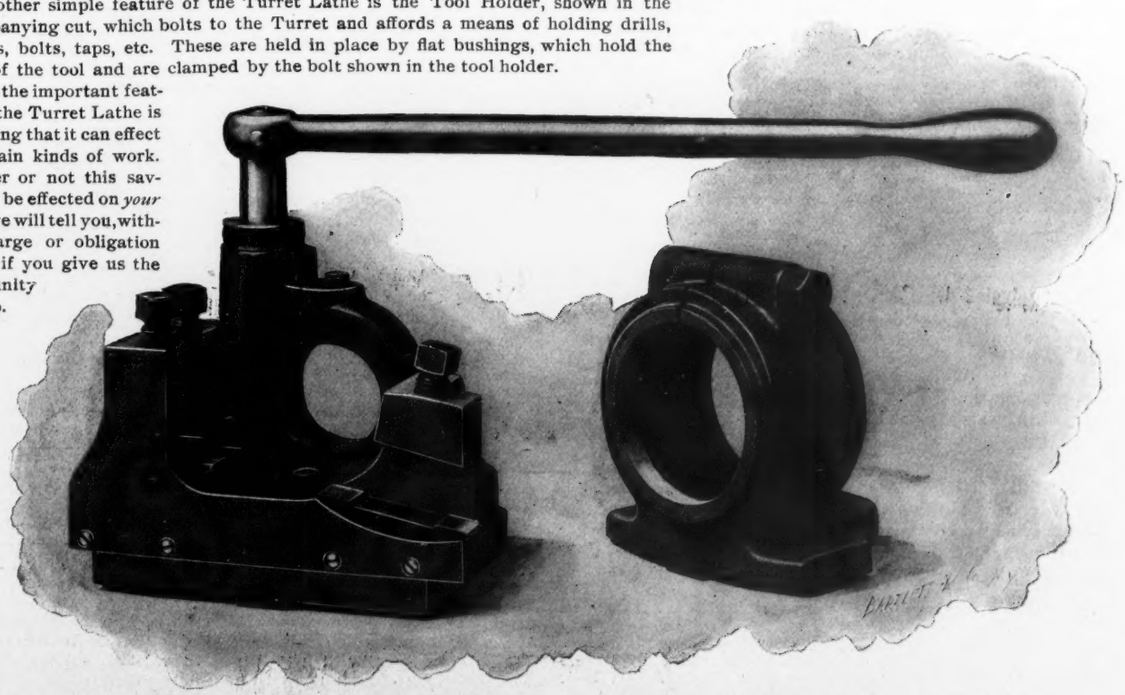
A New Lathe System—XII.

We are glad to mail our new Catalogue to manufacturers.

A feature of the Flat Turret Lathe is the cross slide, which is arranged to hold either the cutting-off tool or forming tools at the back. It is operated by a long lever, which gives it a degree of sensitiveness, as well as power, which cannot be realized from an ordinary cross feed screw fitted with a hand wheel. The slide is very compact, bolts on to the turret and revolves with it like any of the other tools. Bars of any length, up to two inches in diameter, can pass through the cross slide, and be operated upon by the tools held therein.

Another simple feature of the Turret Lathe is the Tool Holder, shown in the accompanying cut, which bolts to the Turret and affords a means of holding drills, reamers, bolts, taps, etc. These are held in place by flat bushings, which hold the shank of the tool and are clamped by the bolt shown in the tool holder.

But the important feature of the Turret Lathe is the saving that it can effect on certain kinds of work. Whether or not this saving can be effected on *your* work, we will tell you, without charge or obligation to buy, if you give us the opportunity to do so.



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FOREIGN REPRESENTATIVES—HENRY KELLEY & Co., 26 Pall Mall, Manchester, England.

M. KOYEMANN, Charlottenstrasse, 112 Dusseldorf, Germany, Selling Agent for Germany, Belgium, Holland, Switzerland and Austria-Hungary.

tance of 1 inch from line *a*. Measure the distance apart of lines *a* and *d*, on line *b*. It is, say ⅛ inch (.125 inch). The ball weighs 100 pounds and will lift 1-inch, while the valve lifts .125 inch; .125:1 :: 100: 800. The effect of the ball to keep the valve seated is 800 pounds. In addition to this there is the effort of the valve and lever. To ascertain what this last named effort is remove the ball and attach a spring balance, as indicated in Fig. 2, and lifting up on it observe its indication, just as the valve loses its seat. Say this is 30 pounds. The valve is 3½ inches diameter; its area is 9.62 inches. Then $\frac{800 + 30}{9.62} = 86.27$. The valve will blow at 86.27 pounds pressure. If it is required to know where the ball should be placed to hold some other pressure, say 60 pounds, consider that the total upward pressure on the valve is $9.62 \times 60 = 577.2$ pounds, of which 30 pounds is balanced by the downward effort of the valve and lever, leaving $577.2 - 30 = 547.2$ pounds to be exerted by the ball. In the first instance, the distance apart of lines *a*, *d*, at the center or gravity of the ball is 1 inch. Now, it will be 800: 547.2 :: 1: .684 inch. The center of gravity of ball will now be at the line between *b* and *c*, that is where *a* and *d* are .684 inch apart. Suppose you want to put the ball in the position just noted, that is, where lines *a* and *d* are 1 inch apart, but you want to carry 100 pounds on the boiler; $9.62 \times 100 = 962$, the total upward pressure on the valve, of which the ball must hold $962 - 30 = 932$ pounds. Then 800: 932 :: 100: 115 the weight in pounds of the ball to be used. In all such solutions the great point is to make fine lines and close measurements. If this is attended to the results will be surprisingly accurate. The plan is of great advantage in checking conclusions mathematically arrived at.

MANUFACTURERS' NOTES.

A CORRECTION.

Through an error the notice of the L. S. Starrett Co. in this column, with reference to a reduction in prices on combination squares, was made to convey a wrong impression. It should have stated that the reduced prices on combination squares, etc., as published in our advertisement of last month are net, they being about 50 per cent. less than the prices which formerly prevailed on those articles.

THE DIAMOND MACHINE CO., of Providence, report an increase in their business with a good volume of foreign orders. They have made several large shipments of their ball case grinder to Austria and Germany recently, and are at work on an order for surface grinders for England. Their universal grinder is finding large sale both in this country and abroad.

THE BLACK DIAMOND FILE WORKS call attention to the fact that they received the award of a silver medal for the excellence of their goods, at the Nashville Exposition. They also state that this was the only and highest award made on these goods, although there were others exhibited.

TRUMP BROS. MACHINE CO., Wilmington, Del., write: We have sold our complete nut plant to the Port Chester Bolt & Nut Co., Port Chester, N. Y., to whom we refer our former patrons in this line.

THE LYNCHBURG BRASS MFG. CO., Lynchburg, Va., is a new concern making electric desk lights, burglar matting, door bells, push buttons, etc. James Stretch goes from Meriden, Conn., to take charge of the foundry department.

THE four factories of the Nicholson File Co., Providence, R. I., closed their producing departments on Friday, the 24th, for a period of nine days till January 3d, in order to effect enlargements and repairs. The executive and shipping departments remain open, to provide for the despatch of orders. Additions are being made to the inside equipment of the factories, while the buildings also are being considerably enlarged. The capacity of the Nicholson plant at Providence, where the famous Nicholson brand is manufactured, will be brought up to where it can more readily meet the demand, while the works at Pawtucket, R. I., and Beaver Falls, Pa., where are made the American and Great Western brands respectively, will be enlarged to admit of a greater production. The company plan to be in a position where they may produce an average of over 70 000 files daily after January 1st.

BUSINESS.

NO CHARGE IS MADE FOR THE INSERTION OF BONA FIDE ITEMS UNDER THE ABOVE HEAD. FOR FURTHER PARTICULARS, ADDRESS THIS OFFICE.

Wanted: A molding machine for globe valves and general cast brass fittings; *not* hydraulic nor compressed air drive. Also a small hydraulic ram for driving in and out locomotive wrist-pins and the like (not crank-pins; cross-head pins).

FRESH FROM THE PRESS.

Steam Boilers, as constructed by Yates & Thom, Canal Foundry, Blackburn, England. Written and compiled by William H. Fowler. 171 8vo pages, illustrated. Price, $1.25.

This is primarily a catalog of the boilers and boiler appliances built by Yates & Thom; but this part of the work is supplemented with much other matter which makes the book as a whole partake more of the nature of a treatise on the subject than of a catalog. The matter is largely descriptive and contains very little that is technical or mathematical. It is well written, however, and is profusely illustrated with cuts, most of which appear to be original and made for this work. It is a book that would form a satisfactory supplement to any of our American books upon boilers if one wanted to become acquainted with English as well as American practice.

Lettering for Draftsmen, Engineers and Students. A practical system of freehand lettering for working drawings, by Chas. W. Reinhart, chief draftsman, *Engineering News;* third edition; 32 pages, 11 x 8 inches, illustrated, with ten plates. D. Van Nostrand Co., New York. Price, $1.50.

Although several styles of lettering are treated in this book, it is mainly devoted to the excellent system which is used for the illustrations and drawings that appear in the *Engineering News.* General principles that are applicable to any system are explained, however, and in this respect we believe the book has generally been counted as one of the best works published. The new edition takes up the subject of lettering on working drawings more in detail; a number of plates and a chapter upon lettering for photo reproduction have been added.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3¼X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

THE L. S. STARRETT CO., Athol, Mass. Catalog of fine mecanical tools and milling cutters. 112 pages. 5¼ x 7½ inches.

This catalog is larger by fourteen pages than the previous edition, and the additional room has been devoted to a description of a number of new tools and cutters. Among them are new styles of steel rules, screw pitch gauges, thickness gauge, steel clamps, surface gauge, plumber's level, levels with protected vials, nail sets, center punches, scribers and a variety of new cutters. Their line of micrometer calipers has been increased to over thirty different styles, including inside micrometers. The smallest is a half-inch tool and the largest measures from 0 to 6 inches. One style is made with drop forged frame and is sold at a low price.

E. G. SMITH, Columbia, Pa. Catalog of measuring instruments. 16 pages, pocket size.

Besides listing "Columbia" sliding and vernier calipers, descriptions and price lists are given of an improved form of quick-acting pocket caliper, a depth gauge, a pocket level, and various styles of micrometers and other instruments for special purposes.

DAVIS & EGAN MACHINE TOOL CO., Cincinnati, O. Catalog of machine tools. 382 pages, 6½ x 4¼ inches.

Besides containing cuts with descriptions of the large line of machine tools of different kinds which this company makes, there are 27 pages of useful information, tables, etc., for machinists, and several pages of information of value to those engaged in foreign trade. A number of new tools are shown and it is stated that still others are soon to be brought out.

WE have received from Timmis & Chissold, Bound Brook, N. J., circulars of the "Carhart" friction clutch and cut-off coupling, which will be sent to any one interested. They also handle an improved steel shrink rule for pattern-makers.

WE have received from the H. W. Johns Mfg. Co. a 16-page circular of the "Vulcabeston" packing for steam users. This company have representatives in the leading cities of this country and in London, and supply packing in the different forms suited to varying needs.

FOR SALE.—One automatic 1 HP. engine and boiler, one Star lathe and fittings. E. C. Row, Osceola Mills, Pa.

WANTED.—Men acquainted with the machinery and manufacturing trade to sell our goods as a side line or exclusively. Liberal commission paid.
THE HOWARD OIL & GREASE CO., Cleveland, O.

FOR SALE—BOILERS AND STEAM PURIFIER.—Changes and enlargements have rendered the following useless to us. They are in good condition, and are offered at low prices: One live steam purifier, 300 HP., Hoppes live steam purifier, 40 inches in diameter, 18 feet long; two boilers 60 inches in diameter, 16 feet long, with fifty 4-inch tubes; two boilers 66 inches in diameter, 16 feet long, with fifty-four 4-inch tubes.
For further information and price, address
Feb THE NATIONAL CASH REGISTER CO., Dayton, O.